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Office of Analysis and Evaluation
Food and Nutrition Service
U.S. Department of Agriculture

PERFORMANCE ISSUES IN AN ELECTRONIC BENEFIT TRANSFER SYSTEM FOR THE FOOD STAMP PROGRAM

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The research reported herein was performed pursuant to contract number 53-3193-3-103 with the U.S. Department of Agriculture, Food and Nutrition Service. Abt Associates, Inc. was the prime contractor. The opinions stated do not necessarily represent official Department position or policy.

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EXECUTIVE SUMMARY

In July 1983, the United States Department of Agriculture, Food and Nutrition Service (FNS), awarded a contract to Planning Research Corporation (PRC) to demonstrate a mechanism for providing Food Stamp Program benefits through electronic-funds-transfer and point-of-sale technologies. In October 1984, an electronic benefit transfer (EBT) system using these technologies began operations in Reading, Pennsylvania. Demonstration recipients were gradually phased onto the new issuance system over four months, and the Reading EBT system was fully operational in February 1985.

For the most part, the demonstration system performed its main functions successfully. Food stamp recipients received their benefits on time and were able to buy food with them. Food retailers were credited correctly for the food stamp benefits they accepted as payment. Although the demonstration was scheduled to end in December 1985, grocers, recipients, and state and local food stamp authorities liked the EBT system well enough that FNS extended the demonstration for two more years. The Department of Agriculture's direct administration of the demonstration, however, did end on December 31, 1985. After a transaction period, the Pennsylvania Department of Public Welfare (PDPW) took over operations of the EBT system in March 1986.

Despite the positive reactions to the EBT system, not all operations went smoothly. A number of performance problems occurred, ranging from slow response times to cumbersome procedures. The problems were not so severe that food stamp benefits could not be delivered and redeemed, but they were serious enough that FNS had PRC modify a number of system features. More important, the problems represent situations that future developers of EBT systems will want to avoid.

This report discusses the major dimensions of an EBT system's performance, with particular attention to points that proved problematic in the Reading demonstration. It defines some general performance objectives for an EBT system, identifies areas in which food stamp authorities might establish performance standards, and suggests system features and management procedures that should enhance EBT performance.

This is the second special-topic report produced as part of the evaluation of the demonstration. The first report describes the general design of the Reading EBT system and the process of developing and implementing the system.[1]

HOW THE READING EBT SYSTEM WORKED

The Berks County Assistance Office issued photo identification cards with magnetic stripes to all food stamp recipients living in central Reading. Recipients used the cards to buy food at any store in the Reading area that was equipped with EBT terminals at the checkout counters. These stores included virtually all Reading-area stores eligible to participate in the Food Stamp Program. When a recipient wanted to make a purchase, the checkout terminal made a telephone connection to computers at an "EBT Center" in Reading, which maintained recipients' food stamp benefit accounts. If the recipient's account had enough benefits to cover the intended purchase, the computer authorized the purchase, debited the recipient's account, and credited the grocer's account. Once a day, the EBT Center totaled each grocer's sales and initiated an electronic funds transfer to credit the grocer's bank account.

SIX DIMENSIONS OF AN EBT SYSTEM'S PERFORMANCE

Any EBT system has to carry out certain basic functions. It has to provide a means for food stamp authorities to set up recipient accounts and to periodically add benefits to the accounts. It has to allow recipients to buy food with their benefits. It has to credit grocers in dollars for the recipients' purchases. Finally, it has to provide food stamp authorities with the information they need to manage the program and to be sure the system operates properly.[2]

An EBT system not only has to perform these functions, it has to perform them well. Criteria for defining good performance, however, are not well established. The technology is relatively new. Even now only a handful

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[1]John A. Kirlin, Developing an Electronic Benefit Transfer System for the Food Stamp Program, Cambridge, Massachusetts: Abt Associates Inc., August 1985.

[2]These and other functional requirements of an EBT system are discussed in some detail in Kirlin, op. cit.

of point-of-sale systems exist in the retail food industry. Banking and merchant groups are attempting to formulate performance standards, but so far their coverage is not comprehensive and the standards suggested by different groups are sometimes contradictory. Thus, few published resources are available to a food stamp agency that needs to specify performance criteria for an EBT system, or to an EBT system developer who needs to know what expectations the system must meet.

Examination of the Reading experience, review of the published literature on commercial point-of-sale (POS) systems, and discussions with some POS system operators in Iowa and Florida suggest six key dimensions of an EBT system's technical performance:

- processing times for all functions, but especially for EBT purchase transactions,
- capacity, which determines the number of food stamp recipients the system can handle at normal performance levels,
- reliability, including the availability of the system to perform its functions and accuracy with which it does so,
- security features that protect the Food Stamp Program against loss and abuse of benefits,
- management information for food stamp authorities and system operators, and
- ease of use of the EBT system for recipients and grocers.

Recommendations to help ensure good performance of an EBT system on these dimensions are summarized below.

PROCESSING TIMES

Specify performance standards for transaction times before system design begins.

The key standard should concern the length of time the payment transaction takes in the grocery store (i.e., from when the customer's card is passed through the card reader until the receipt is printed). POS operators

in Florida and Iowa estimated this time for a normal POS transaction at 20-23 seconds -- somewhat faster than the average cash transaction as estimated in industry studies. Measured time for normal EBT transactions in Reading averaged about 60-70 seconds, or 30-35 seconds slower than equivalent cash transactions. Grocers in Reading, however, did not complain about the time required for normal transactions.

The system design may make it difficult to measure transaction time from the moment of initiation. It may be necessary to have a "response time" standard as well, measuring the time from when the central computer begins to receive an incoming transmission until it completes its return transmission. A supermarket industry group has suggested a response time standard under 10 seconds. Estimates for the two POS systems examined were 8-15 seconds, compared to 24-28 seconds in Reading.

Estimate expected transaction volumes and size the system accordingly.

Food stamp recipients in Reading averaged 7 to 9 EBT purchase transactions per month. Peak volumes in the afternoon hours immediately following issuance were quite high: the single-hour peak ranged from 0.9 percent to 1.3 percent of the whole month's transactions. Both factors were under-estimated in planning the Reading system, causing slow processing during peak hours.

Design system operations to limit peak loads where possible.

Staggering food stamp issuance, rather than giving all recipients their benefits on the same day, can reduce peak loads. Reading data suggest that issuing benefits on two days, one week apart, could cut peak daily volume by nearly 24 percent from the volume with single-day issuance.

Large batch-processing operations, such as totaling grocer credits for the daily funds transfer, compete with purchase transactions for processing capacity. If these operations occur during the mid- to late-afternoon hours, they will add to peak demands on the system. Where possible, batch operations should be scheduled for off-peak hours or designed not to compete with the processing of purchase transactions.

households will still have benefits in their accounts after their food stamp case has officially been closed. In Reading, the number of households making purchases each month was 2 to 4 percent greater than the number receiving benefits.

The EBT system carries out various transactions other than food purchase authorizations, such as benefit issuance, card encoding, and balance inquiries. The total number of transaction records the Reading system had to generate and store averaged about 30 percent more than the number of purchases.

To avoid overburdening a system's file capacity, food stamp authorities need to establish a policy for removing accounts from an EBT system's active files after a period of inactivity. For instance, even though the caseload in Reading remained fairly stable throughout the demonstration, the number of accounts on the system increased by 50 percent as new cases were added but closed cases were not deleted. Deciding when to delete accounts is somewhat difficult, because some cases that the Food Stamp Program considers closed will continue to have unused benefits. How much additional file capacity an EBT system needs for these accounts depends on how long authorities decide they must be maintained.

Plan capacity for peak demands, considering all system functions, and leave a margin for error.

Peak demands for processing capacity in Reading occurred in the afternoons when purchase volumes were high and the system also had to sum up the day's purchase activity to initiate funds transfers to grocers. Limited capacity, as well as the factors noted earlier, contributed to slowdowns.

Communications capacity also is subject to demand peaks. The Reading system initially had six incoming telephone lines to handle purchase transactions, but added a seventh line when some grocers complained about access problems. Capacity here is best measured as the probability that a store terminal will encounter a busy signal when attempting to connect with the central computer. That probability was measured at .005 after the seventh line was added.

Select hardware and software to meet processing time requirements.

Many system designs can yield adequate processing time, and the factors that will make any given system fast or slow are very system-specific. Among the causes of slow processing times in Reading were serial processing of various kinds of transactions through a single control module, simultaneous updating of data files on a primary and backup computer, and use of PL/1 as the system's programming language. Software written in PL/1 requires a relatively large amount of code which the system must read and interpret, thereby slowing processing speeds.

Food stamp authorities will not necessarily be in a position to specify design decisions at this level of detail. They can, however, make sure that hardware and software designs are reviewed by individuals with expert knowledge of the particular hardware models and software languages being proposed. This design review should assess the system's likely performance capabilities and compare these capabilities to the system's specified performance standards.

Test the system thoroughly before implementation.

System testing should include measuring the various components of processing time for a purchase transaction: card reading and other functions that happen at the store before transmission, dial-up and communications time, internal processing, and printing the receipt. Measurements should be conducted for a single transaction to determine any sources of slow processing time. Measurements also should be conducted for multiple transactions in a simulated peak-load situation to test the effect of transaction volume on overall processing times.

SYSTEM CAPACITY

Estimate expected recipient numbers and transaction volumes.

In addition to the number of purchases per recipient, the EBT designer needs to know the number of active recipient accounts to plan system capacity. Active accounts will exceed normal "caseload" figures, because some

Although there is no standard for capacity planning, POS system operators contributed a rule of thumb about allowing a margin for error. They suggested designing a system in which the expected level of operations would use 40 to 60 percent of capacity, and being ready to expand capacity when utilization hits 80 percent.

Design the system to make it easy to expand capacity.

It may be necessary to add capacity to an EBT system after it begins operations, as was the case in Reading. System design should make it possible to add processing capacity (e.g., a faster computer or a computer with more memory), communications capacity (e.g., incoming telephone lines), or storage capacity for system files (e.g., more or larger disk storage devices) with a minimum number of changes to other system elements.

Monitor utilization to identify potential capacity problems.

All system activities must be monitored after implementation to make sure that actual usage is consistent with the levels used in capacity planning. Measures of demand for processing and communications capacity should include separate figures for peak periods.

SYSTEM RELIABILITY

Specify reliability standards for major system elements before the system is designed.

The most common system reliability measure is the "uptime rate" -- that is, the percentage of all scheduled operating hours that the central computer system is working and able to accept transactions. Trade literature often mentions a standard of 99.5 percent uptime. The observed POS systems exceeded this standard, and the Reading system came close (99.4 percent overall, but 99.7 percent during daytime hours).

For an EBT system, downtime that occurs between 4:00 PM and 5:00 PM on issuance day is more damaging than downtime between 4:00 AM and 5:00 AM on a Sunday morning. A separate uptime standard should be applied to peak

periods; alternatively, the overall standard could be specified in terms of the minimum percentage of attempted transactions which the system must process.

The uptime rate does not account for system inaccessibility that is caused by failure of the communications system, the recipient's card, or the in-store equipment. A measure of communication system reliability (probability of a busy signal) was discussed above.

Card reliability can be judged by average lifetimes. Bank cards appear to have at least a two-year average lifetime. Reliability problems with the EBT cards in Reading began to appear about six months after card issuance, although data needed to compute average lifetimes were not maintained.

In-store equipment reliability should ideally be evaluated in terms of the percentage of transactions that cannot be completed because of equipment failure. No data on this point are available either from Reading or from the POS systems in Iowa and Florida. The most relevant measure from Reading concerns reported equipment problems, which occurred for about 8 percent of the terminals each month. Most of these problems were minor and easily fixed; the Reading in-store equipment was generally considered quite reliable.

A standard of nearly 100 percent accuracy in processing financial transactions seems achievable. Only a handful of errors were found in nearly 500,000 purchase, issuance and funds transfer transactions in Reading, and POS systems report similar accuracy rates.

Thoroughly test all hardware and software and train system operators before implementing the system.

Hardware and software "bugs" are almost inevitable, and some will occur in specialized situations that never develop in even the most rigorous testing. In Reading, for example, if a cashier made a particular error in signing on a store terminal, the terminal might later send a message to the EBT Center that caused the main computer to fail. The voice-input-output unit that received recipients' telephone inquiries about their account balance sometimes failed to answer, for reasons that were never determined. It cannot

be assumed that pre-implementation testing will eliminate all such problems, but extensive and varied testing can help minimize them.

Nearly 10 percent of system downtime in Reading was attributed to operator error. These problems were concentrated in the early months, suggesting that more training might have improved system reliability during this period.

SYSTEM SECURITY

Perform a vulnerability analysis of any proposed EBT system design and review system security after implementation.

Experience to date provides no basis for specifying general security standards for an EBT system. The most common current approach to determining security needs is vulnerability analysis. This amounts to a comprehensive listing of the ways in which system integrity might be breached, together with the potential methods for protecting against each vulnerability. Given such information about a proposed EBT system design, food stamp authorities can decide which vulnerabilities are important enough to justify the cost of the protective measures.

System vulnerabilities should be defined to include mischief as well as theft. A consultant hired by FNS failed to penetrate the Reading system's security, but found it possible to tie up incoming lines. Such an event occurring on an issuance day would have caused great inconvenience and confusion, although the system would have incurred no financial loss. The experience illustrates the need for post-implementation security reviews, which may identify vulnerabilities not noted in the initial analysis.

Design the system to facilitate data encryption and message authentication to protect data transmissions.

Some data in an EBT system may have to be transmitted over non-secure telephone lines. Standards are currently being developed for encryption and message authentication in financial data transmissions. (Encryption involves altering the data so it cannot be interpreted if it is read during transmission. Authentication procedures usually add a special code, based on

the data being transmitted, so the receiver can determine that the transmission is legitimate and unaltered.) EBT systems should implement these standards wherever message protection is appropriate.

The Reading system used message authentication for transmissions from stores to the EBT Center and encryption for transmissions from the state and local welfare offices. This protection was considered good, and it withstood the penetration attempt described above. Encrypting the state's issuance transmissions, however, was cumbersome and not always done. (Encryption required daily access to an inconveniently located encryption device.) Software for future EBT systems may need to be designed to reject non-encrypted transmissions to deter such short-cuts.

Require recipients to use PINs.

The desirability of Personal Identification Numbers (PINs) in POS systems is still under debate. Some retailers balk at the added cost and inconvenience posed by PIN use, but financial institutions like the added protection PINs provide. Requiring the use of PINs seems to be a valuable security device in an EBT system. The Reading system required PINs, as did the POS systems examined. The PINs apparently caused no problems in any of the systems.

Design a complete and timely reconciliation system.

Daily checks are needed to make sure that an EBT system stays "in balance" -- i.e., that total benefits in recipients' and grocers' accounts today are equal to yesterday's total, plus any new issuances or purchase credits, minus any purchases, debits, or deposits transmitted. This kind of reconciliation is done for the system as a whole and for each recipient's and grocer's account.

Transfers to and from the EBT system also must be reconciled to be sure that the amount received (sent) by the EBT system agrees with the amount sent (received) by the other party.

The Reading reconciliation design, which incorporated these features, was generally considered good. Some problems arose because of delays

in reconciliation functions that were performed by parties outside the EBT system. Prompt reconciliation is important both to catch any illegitimate activity quickly and to keep reported discrepancies from confusing subsequent reconciliation efforts.

Provide a complete audit trail.

All system operations affecting account balances should be documented so that accounts can be fully audited. To provide this documentation, the computerized operation of an EBT system can easily create and retain records of all actions that move benefits from one account to another. If account adjustments are needed to correct processing errors or other unforeseen situations, system operators should document the details of the adjustment and why it was needed. If system operating procedures require authorization for account adjustments, the documentation should include the authorization.

SYSTEM MANAGEMENT INFORMATION

Specify management information needs before system design.

Food stamp authorities need information about how well an EBT system operates relative to its performance standards, and about the incidence and cause of system problems. In the Reading demonstration, where the system was operated by a vendor under a cost-reimbursement contract, FNS also needed information about system costs and about changes to the system design and operating procedures. If the system is likely to expand or to be applied elsewhere, information on utilization patterns also is needed. Food stamp authorities must specify these needs in detail, because not all of them will be evident to system operators.

Of course, some information needs cannot be fully anticipated. The system design should be flexible enough to allow adjustments to the report contents after operations begin. The software for producing reports in Reading was not very flexible, and some adjustments that FNS desired were not made because extensive redesign would have been required.

Test all reporting software and procedures before system implementation.

Management reporting tends to be overshadowed in pre-implementation testing by the main benefit-handling functions. Testing the reporting functions is nonetheless important, particularly because the reports for the first few periods will be critical to identifying any system problems. It may be necessary to simulate multiple reporting periods in order to test the reports fully prior to system implementation.

Although reports were specified in detail for the Reading demonstration, a number of ambiguities were not discovered until the first "real" reports were produced. If system tests had included reports based on simulated data, most of the problems could have been corrected before system implementation.

Review the system's ability to provide management information on appropriate schedules.

Management reporting functions may be time-consuming and will necessarily receive lower priority than a system's main operating functions. In Reading, given these factors and the system's capacity limitations, the main monthly management reports usually were not provided until several weeks after the end of the month.

SYSTEM EASE OF USE

Limit the number of separate or complicated actions that recipients and grocery personnel have to take to process a normal purchase transaction.

Normal purchase transactions were quite simple for recipients and retailers in the Reading EBT system and the POS systems. Recipients and grocers overwhelmingly preferred EBT to the normal food stamp coupon system, predominantly because they considered the EBT system easier to use.

Provide complete and timely deposit information to grocers.

Many retailers need to be able to reconcile in-store records of EBT sales with deposits to their bank accounts on a daily basis. The POS systems in Iowa and Florida provide such information in great detail, but the Reading system was not designed to give grocers any routine information other than their monthly bank statement. The matter was confused by delays in recording manually authorized sales (used when purchases could not be made electronically); the delays meant that daily deposit totals might not correspond to in-store totals.

The information grocers need will be readily accessible within the EBT system's computer files. Transmitting the information in a useful form to grocers requires additional system capacity and cost, however, and it may not be easy where in-store terminals are not very sophisticated, as in Reading.

Avoid stringent limits on manually authorized purchases.

An EBT system must have procedures allowing recipients to use their food stamp benefits when the electronic system fails. Designing these procedures requires a tradeoff between making the system easy to use and limiting the potential for recipients to overdraw their accounts.

In the Reading system, a recipient could use no more than $35 of benefits in manually authorized purchases in any one day. The limit inconvenienced grocers and recipients, but probably made very little difference in the system's vulnerability to overdrafts. Food stamp authorities might consider imposing such a limit when an EBT system begins operations, then using a higher ceiling after verifying that manual transactions occur only infrequently.

Make it easy for recipients to spend their exact remaining account balance.

Unlike customers in a commercial POS system, food stamp recipients often want to use all of the benefits remaining in their account. Recipients could find out their remaining account balance fairly easily in the Reading system -- more easily than the POS systems. Still, recipients often used a

trial and error process: attempting a purchase, receiving an "insufficient funds" message, and then attempting the purchase again for the exact remaining amount. In future systems, interaction between store terminals and the central computer might be specifically designed to accommodate such purchases.

Provide thorough training to grocers and recipients.

Recipient training and support in the Reading system was considered very good, and could serve as a model for other systems. Recipients were trained in group sessions lasting about an hour and involving a videotape presentation and hands-on practice with the equipment. Staff of community organizations were trained to help any recipients having problems with the system, especially problems arising from language and communication barriers. This resource, however, was rarely used.

Grocer training in Reading was considered less successful. The system developer trained grocers in group sessions lasting about half an hour. The training included more material than recipients' training, but offered limited hands-on practice. The system developer did offer subsequent in-store training, if requested by the store manager.

Supermarket representatives in the POS systems said they trained employees in groups in their stores for one to two hours, with emphasis on hands-on practice. Although in-store training may not be feasible in a large-scale implementation, the longer sessions and hands-on emphasis seem appropriate for EBT systems.

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LIST OF EXHIBITS

ACKNOWLEDGEMENTS

Many people contributed to the preparation of this report on EBT system performance issues. The authors wish to extend special thanks to the following individuals, without whose assistance the report surely would have been less thorough and comprehensible.

Carol Olander, of the Office of Analysis and Evaluation of FNS, provided the initial impetus for the report and offered many valuable suggestions on report content and organization along the way. Linda Basham, Project Officer for the EBT demonstration, and Jeff Cohen -- both from the Office of Family Nutrition Programs at FNS -- monitored the operations of the system in Reading and provided valuable information on issues related to the actual performance of the Reading EBT system.

Many individuals at Planning Research Corporation -- the contractor selected to design and operate the EBT system -- assisted us by providing detailed information on system design and lay explanations of the performance problems the system encountered. We would like to extend our special appreciation to Donald O'Dell, Project Director, and Fred Jones, EBT Center supervisor.

Gary Rightmire, Director of the Berks County Assistance Office, was quite helpful in providing information on his office's EBT operations, as were members of his staff and other personnel of the Pennsylvania Department of Public Welfare.

Three consultants with POS expertise reviewed early drafts of the report or otherwise offered worthwhile comments on system performance issues. We would like to thank Thomas Marschall of Bank Earnings International, Rick Canter of Beacon Software Inc., and Charles King of Bank of America.

Finally, the report makes many comparisons between the Reading EBT system and two commercial POS networks with extensive operations in grocery stores. We would like to thank Dale Dooley, president of ITS in Iowa, and Mike Strada, president of HONOR in Florida, for allowing us to visit their organizations and probe into the similarities and differences between their networks and the Reading system. We also wish to thank the management

personnel at the three grocery store chains we visited on these trips: especially Robert Hand, president of Dahl's Foods; Richard Newell, vice-president and treasurer of Hy-Vee Food Stores; and Earl Andrews, assistant director of EFT operations at Publix Supermarkets. None of these network or store personnel had any association with the Reading demonstration, and their willingness to take time to meet with us is especially appreciated.

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Chapter One

INTRODUCTION

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Chapter One

INTRODUCTION

The Food Stamp Program provides benefits to needy households to help them purchase food items authorized under the program. Benefits are currently provided in the form of food stamp coupons with specified face values, which may be redeemed by purchasing groceries at authorized retail outlets. The United States Department of Agriculture, Food and Nutrition Service (FNS), administers the program.

For several years, FNS has sought alternative ways to provide food stamp benefits. The agency has looked for issuance procedures that are more efficient, less costly to administer, and less vulnerable to fraud and abuse than the most frequently used coupon systems. One alternative approach applies electronic-funds-transfer (EFT) and point-of-sale (POS) technologies to the benefit issuance and redemption processes. In January 1983, FNS solicited proposals from independent contractors to design, develop, and pilot test an Electronic Benefit Transfer (EBT) system using these technologies. Planning Research Corporation (PRC) won the competition, and in July 1983, FNS awarded PRC a contract to test such a system in Reading, Pennsylvania.

The Reading EBT system began operations on October 1, 1984. Fifteen months later, on December 31, 1985, the EBT demonstration ended. The original plans called for demonstration participants to return to the coupon issuance system after the end of the demonstration. However, responding to a request from the Pennsylvania Department of Public Welfare (PDPW), FNS extended the EBT demonstration in Reading for another two years. Under an arrangement worked out between PDPW and FNS, responsibility for operating the EBT system has been shifted from Planning Research Corporation to the state welfare department.

1.1 PURPOSE AND OBJECTIVES OF THE REPORT

A previously released report on this project documented the design, development and implementation of the Reading EBT system.[1] A major purpose of that report was to help state food stamp authorities who might contemplate implementing an EBT system. The report covered a number of operational requirements and other issues to be addressed when designing, developing and implementing an EBT system for the Food Stamp Program.

When food stamp authorities seek to establish an EBT system, however, their responsibility does not end with specifying appropriate operating requirements. It includes specifying system performance standards before the system is designed, and evaluating the system's technical design before development is begun. These responsibilities exist whether the system is designed and developed by an independent contractor (as in the Reading demonstration) or by a State Agency.

With these responsibilities in mind, the current report provides information to food stamp authorities about appropriate performance standards for EBT systems and potential technical problems that can arise during system operations. Clear performance standards can avoid misunderstandings between food stamp authorities and system developers about expected levels of system performance. Recognizing and reacting to potential technical problems can prevent operational problems after a system is implemented.

To aid food stamp authorities in specifying performance standards and in evaluating the technical aspects of a proposed system design, this report has four major objectives:

- to identify general performance issues for EBT systems operating in the environment of the Food Stamp Program,
- to document performance standards being applied to existing POS networks, especially those networks with point-of-sale operations at retail food outlets,
- to identify potential areas in which technical problems can develop in EBT systems, in part by identifying

[1] John A. Kirlin, Developing an Electronic Benefit Transfer System for the Food Stamp Program, Cambridge, Massachusetts: Abt Associates Inc., August 1985.

problems (and their causes) which developed during the Reading EBT demonstration, and

- to present recommendations which food stamp authorities can follow to reduce the number of technical problems which may develop during the design and development of an EBT system.

The report concentrates on six aspects of the technical performance of EBT systems. Each is addressed in a separate chapter of the report:

- system processing times (Ch. 2),
- system capacity (Ch. 3),
- system reliability (Ch. 4),
- system security (Ch. 5),
- system management information (Ch. 6), and
- system interaction with users (Ch. 7).

The first four areas deal specifically with operational parameters of an EBT system. That is, how quickly transactions at the point of sale are processed; how well the size of the system corresponds to demands on the system; how reliable the system is in terms of user accessibility and processing accuracy; and how secure are system files and transaction communications. The management information chapter deals not so much with how the system operates from the perspective of users, but with the information that system operators and State Agencies need to ensure that the system is operating correctly. The user interaction chapter focuses more on problems with system design than with technical problems in system operations.

As noted earlier, one purpose of identifying potential technical problems in EBT operations is to help food stamp authorities evaluate proposed system designs before development proceeds. It must be recognized, however, that evaluating the technical design of an EBT system is a complex task. Such systems rely upon advanced computer systems and communication facilities. Computer software for EBT systems may involve numerous different programs which interface in a complicated fashion. No single document could provide all the information that would be needed to evaluate all possible designs.

Thus, this report cannot substitute for the expertise of individuals who are familiar with the particular hardware and software components being considered. When such expertise is not available among Food Stamp Program staff, authorities will need to find outside persons or firms to help in evaluating technical designs. The report does, however, identify many of the technical areas where problems may develop. It should help food stamp authorities to more effectively communicate their concerns to either the system developer or any consultants employed to evaluate a proposed system.

1.2 INFORMATION SOURCES FOR THE REPORT

The Reading demonstration provides the only operating experience to date with an EBT system for the Food Stamp Program. Most of the information presented in this report is therefore based on the Reading experience. This section describes the information sources used to document the Reading system. It also describes the procedures used to obtain information on performance standards and the operating difficulties encountered in commercial point-of-sale networks operating in the environment of the retail food industry.

The operations of the Reading demonstration system have been well documented. As system developer and operator, PRC provided written documentation of the design of the system, as well as written training guides and operating manuals. During the 15-month period of actual operations, system-generated management reports documented the nature and level of system activity and operations. Much of this information also exists in computer files which document all transactions processed by the system during each month of operations. In addition, numerous other information sources documented regular system activity and system problems:

- Problem call logs document all calls from retailers to the EBT Center about problems the retailers experienced with either the system or the equipment in their stores.
- Manual authorization logs document all calls from retailers to the EBT Center requesting authorization for manual sales when the system was inaccessible.

- System downtime reports identify all periods during a month when the system was down and inaccessible to retailers, as well as the causes of the downtime.

- Call sequencer reports document the level of usage of the telephone lines to the system's computers.

- System reconciliation reports summarize all system accounts at the end of each day to allow reconciliation of all transactions transferring funds throughout the system.

- System operator logs document all computer activities performed by system operators each day.

In addition to these logs and reports, several other sources provide information on activities and, most importantly, problems encountered during the demonstration. Each month, PRC provided FNS with a Monthly Technical Progress Report. These reports summarize system usage during the month, describe problems encountered by the system, and describe actions taken by PRC to address these problems. FNS maintained weekly summaries of contract activities and periodic meetings held between FNS and PRC. Furthermore, two consulting firms, Electronic Banking Inc. (EBI) and Beacon Software Inc., provided written critiques of the EBT design and PRC's proposals to improve system operations.

Together, the above documentation provides extensive information on system operations, problems encountered during the demonstration, and actions proposed and taken to resolve these problems. To supplement this information, interviews were conducted with representatives of FNS, PRC, PDPW and the Berks County Assistance Office (BCAO) to clarify the nature and cause of problems and the remedial actions taken in response to these problems. Finally, as part of its evaluation of the impacts of the EBT system, Abt Associates conducted time studies of issuance-related activities at BCAO and all activities at the EBT Center. Field staff also observed purchases at checkout counters to provide information on the impact of the EBT system on checkout counter productivity.

To gain information on system performance and problems encountered in other POS systems, the authors of the report met with representatives of two commercial POS networks and several grocery store chains participating in POS networks. The two networks are SHAZAM and HONOR, both of which include

relatively extensive POS activities at grocery stores. The SHAZAM network is operated by ITS, Inc., headquartered in Des Moines, Iowa. The HONOR network is operated by the Florida Interchange Group, Inc., headquartered in Orlando, Florida. The grocery store chains include Dahl's Food and Hy-Vee Food Stores, Inc. in Iowa, and Publix Supermarkets in Florida. Publix, in addition to participating in the HONOR network, operates its own PRESTO network.

1.3 A DESCRIPTION OF THE READING EBT SYSTEM

This report focuses on general performance issues for an EBT system and possible performance standards which can be specified for these systems. Problems experienced in the Reading EBT system are reviewed to identify potential impediments to performance in other EBT systems. To facilitate later discussion and interpretation of the problems encountered in Reading, this section reviews the design of the Reading EBT system as it existed during the demonstration.

SYSTEM OVERVIEW

The EBT system in Reading is an on-line computer network linking a central computer facility with about 145 retail food outlets in the Reading area, the welfare office in Reading, and the state welfare department in Harrisburg. The central facility, the EBT Center, contains two IBM Series/1 computers and is physically located within the data processing department of American Bank and Trust Company (AB&T). A nearby annex provides work space where field technicians repair and maintain store equipment, and where supplies and spare parts are stored. The EBT Center processes all transactions generated within the EBT system and maintains current files on recipients' and retailers' account balances.

The state welfare department (PDPW) transmits benefits to recipients' accounts at the EBT Center. Recipients' regular monthly allotments are added to their accounts on specified days each month. Supplemental, expedited, and prorated issuances are transmitted and added to the accounts daily.

The local welfare office (BCAO) issues plastic photo identification cards to all participating food stamp households. (Similar cards are used in

other Pennsylvania counties for identification purposes only.) The cards have a magnetic stripe on the back of the card. The photo ID cards are converted to Benefit Identification Cards (BICs) for the demonstration when their magnetic stripes are encoded with a BIC number assigned by the EBT system and a "PIN offset." The PIN offset is a code based on the BIC number and a client-selected Personal Identification Number (PIN). The BIC number and PIN offset are used to verify that EBT benefits are obtained only by legitimate recipients.

Recipients purchase groceries at any retail food outlet participating in the demonstration. Each outlet is equipped with one or more Benefit Transaction Terminals (BTTs) at checkout counters. As illustrated in Exhibit 1-1, each BTT has a handset, which may be used to call the EBT Center for assistance, and a card reader. A PIN-pad and printer are attached to the BTT.

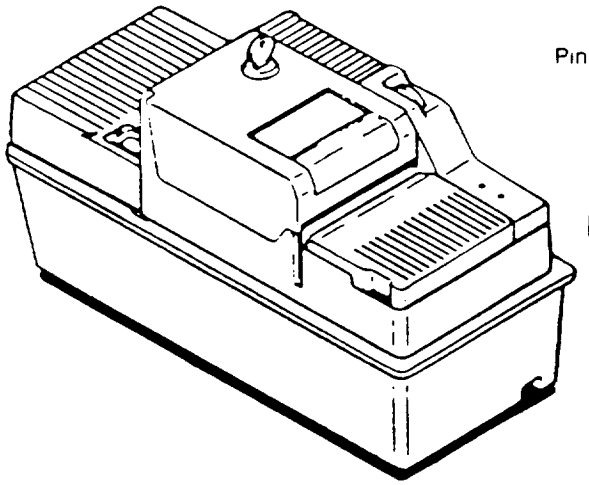
Immediately before a purchase, the store clerk passes the recipient's BIC through the BTT's card reader, and the recipient enters his or her four-digit PIN on the attached PIN-pad. The BTT internally checks the PIN entry with the encoded PIN offset to ensure that the card is being used by an authorized person. Once the PIN is verified, the retail clerk enters the purchase amount on the BTT and presses a "Send" key on the terminal. This action electronically transmits the recipient and store account numbers, the PIN offset, and the purchase amount to the EBT Center over a commercial telephone line. The recipient's account at the EBT Center is immediately debited by the amount of purchase, and the retailer's EBT account is simultaneously credited by the same amount.

After the end of each banking day (2:00 PM), the EBT Center electronically "bundles" all retailer credits for the day. The total credit for each retailer is written on a computer tape which is hand-carried to AB&T's data processing section. AB&T then transfers funds electronically through the Automated Clearing House (ACH) network. The funds transfer passes through the Federal Reserve System. Ultimately, the Food Stamp Program's demonstration account at the United States Treasury is debited by the day's total transactions, and retailers' banks accounts are credited by the appropriate amounts.

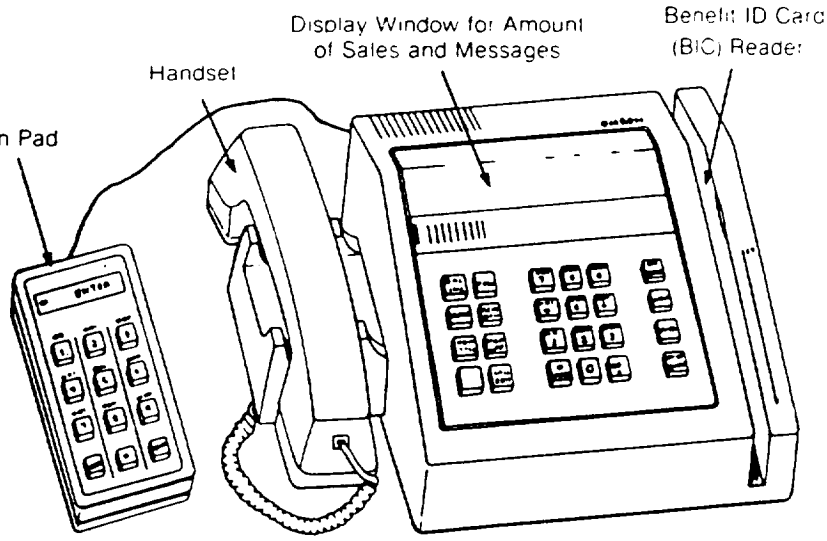
The EBT Center has a backup computer to enhance system reliability. Nevertheless, in the event that electronic transactions cannot be ac-

Exhibit 1-1

Benefit Transaction Terminal and Printer



Benefit Transaction Terminal (BTT) Printer



Benefit Transaction Terminal (BTT)

cepted at the EBT Center, retailers can manually process purchase transactions (up to $35 per recipient each day) by calling the EBT Center and obtaining a manual transaction authorization.

The EBT system does not affect the procedures for certifying a household's eligibility for food stamps. Nevertheless, it changes nearly all the procedures for issuing and redeeming food stamp benefits. The following sections describe the operations of the EBT system for the following six functions and indicate its major differences from the current food stamp coupon system:

- benefit authorization,
- benefit delivery,
- verification of recipient's identity,
- recipient redemption,
- retailer redemption, and
- bank redemption.

Subsequent sections describe the reconciliation process performed within the system and the management reports produced.

BENEFIT AUTHORIZATION

Under both the Authorization-to-Participate (ATP) system (the coupon system that was replaced) and the EBT system, the state welfare department authorizes a certain level of benefits for each recipient each month. The ATP system authorizes benefits through three steps: placing Household Issuance Record (HIR) data and current issuance authorization information on the Food Stamp Master File, printing ATP cards, and distributing ATP cards. In Berks County, ATP cards are mailed directly to recipients.

The EBT system does not alter the first step. Responsibility for maintaining and updating the Food Stamp Master File remains with the state welfare agency. The EBT system does make significant changes in the other two steps.

Benefit Issuance. The computer file that is normally used to print ATPs now contains an identifier on each household's record indicating whether or not the household is in the EBT demonstration. The records for demonstration households are extracted from the file every day, before it is used to print ATPs.

Each day's file extract, containing case numbers and authorized issuance amounts, is sent to the EBT Center. The state welfare department transmits supplemental, prorated and other non-recurring issuances electronically over a commercial telephone line. For the regular monthly issuances, which involve more cases, a computer tape is physically delivered to the EBT Center.[1] Although regular issuances could be transmitted electronically, it would take several hours given the size of the file and the speed of transmission.[2] Neither the state welfare department nor the EBT Center wanted to tie up their equipment that long for the delivery of regular issuances.

When the EBT Center receives issuance information for new cases, it adds account records to the EBT Master File and credits the corresponding issuance amounts to the accounts. For existing cases, the issuance amounts are added to the recipients' existing balances.

Card Issuance and Recipient Training. Under the EBT system, the recipient's encoded Benefit Identification Card (BIC) replaces the ATP card as the document authorizing the delivery of food stamp benefits. Instead of receiving a new ATP card in the mail each month, demonstration participants receive only one BIC. Any lost, stolen, or damaged BICs need to be replaced.

A household that applies for food stamps usually gets its BIC about four days after the application interview. The delay is necessary to verify

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[1]For the first nine months of the EBT demonstration, regular monthly benefits for all food stamp recipients in Berks County were issued by the fourth work day of the month. The issuance schedule changed in July 1985. Beginning in July, approximately one-half of all recipients in Berks County received their benefits on the fourth work day of the month. The remaining recipients received their benefits on the ninth work day of the month.

[2]The state welfare department and the EBT Center use 1200 baud modems to transmit issuance data over a commercial telephone line. Faster transmission would require the use of a dedicated telephone line and higher speed modems.

the information that the client provided, to determine eligibility, and to transmit the necessary data to Harrisburg and the EBT Center. (Households

to do and whom to call in the event of problems. The recipient practices using the BIC with EBT equipment like that located in the grocery stores.

To allow other members of the food stamp household or authorized representatives to purchase groceries, the recipient is given an Alternate Shopper Card. This card includes the recipient's name and case number, but it does not have a photo or a magnetic stripe. When the Alternate Shopper Card is used together with the recipient's BIC and PIN, a person designated by the recipient may buy groceries using the recipient's food stamp benefits.

When a BIC is lost, stolen, or damaged, the recipient notifies the welfare office. The welfare office passes on the information to the EBT Center, which places the recipient's EBT account on "hold." This prevents any further transaction activity for the account. A new card is then assigned to the recipient using the process described above. The household's EBT account is updated with the new BIC number and PIN offset, and the hold status is removed.

BENEFIT DELIVERY

Under the ATP system, recipients take their ATP cards to a local issuance office to obtain food stamp coupons. In Reading, banks serve as issuance offices. After the bank employee verifies the identity of the recipient, the recipient exchanges the signed ATP card for the authorized amount of food stamp coupons.

The EBT system essentially eliminates this step. Benefits are considered to be delivered when they are placed in the recipients' EBT accounts.

VERIFICATION OF RECIPIENT'S IDENTITY

The recipient's identity is verified at two points in the ATP system. As mentioned above, bank employees verify the recipient's identity when they accept the ATP card and provide food stamp coupons. The teller compares the name and signature on the identification card with the name and signature on the ATP card. In addition, when coupons are used to purchase food items, store clerks may ask to see an identification card to verify that the purchaser is an authorized food stamp recipient.

Under the EBT system, store clerks are expected to check the photo on the BIC before attempting the EBT transaction. If someone other than the recipient presents the BIC to purchase groceries, that person also must present the recipient's Alternate Shopper Card.

The EBT system also verifies the identity of the recipient through the four-digit PIN. A Benefit Transaction Terminal (BTT), located at the checkout counter, performs the check. The checkout clerk passes the recipient's BIC through the BTT's card reader and instructs the recipient to enter his or her PIN on a PIN-pad attached to the BTT. The BTT internally computes a PIN-offset number based on the card's BIC number and the entered PIN. It then compares the computed number with the PIN-offset number encoded on the card. If the offsets do not match, the recipient must re-enter the PIN. If the recipient fails to enter the correct PIN in three tries, the BTT will accept no further attempts to use the BIC until another recipient's BIC has been used at that BTT. After the third incorrect entry, the BTT automatically transmits information about the unsuccessful PIN entry to the EBT Center.

Allowing three attempts to enter the correct PIN at the BTT represents a compromise between maintaining system security and recognizing that recipients might have problems remembering their PINs. Multiple attempts to enter a correct PIN could represent an unauthorized person attempting to discover a recipient's PIN through trial and error. Recipients who forget their PINs must return to the welfare office and have their BICs re-encoded with a new PIN offset.

RECIPIENT REDEMPTION OF BENEFITS

Recipients redeem their benefits in the ATP system by exchanging food stamp coupons for food items at authorized retail food outlets. In the EBT system, benefits are similarly redeemed when a recipient uses the BIC and PIN to purchase food items.

Electronic Purchases. In each participating store, nearly all checkout counters are equipped with BTTs, PIN-pads and printers. Recipients may make food stamp purchases at any counter that is so equipped.

After the checkout clerk rings up the sale, the BTT verifies the recipient's identity as described above. The clerk then enters the total food

stamp purchase amount on the BTT and presses a "Send" key. The BTT automatically dials the EBT Center computer and transmits the following information:

- recipient's BIC number and PIN offset (which identifies the appropriate account);
- store, clerk, and BTT identification numbers;
- purchase total; and
- Transaction Authorization Code (TAC), a number which the BTT computes, based on the data to be transmitted.

The EBT Center, upon receiving the transmission, independently computes a TAC and compares this with the transmitted TAC to ensure that the information has been communicated accurately.

The computer at the EBT Center verifies that a valid EBT account exists for the transmitted BIC number and PIN offset. If a valid account exists, the computer compares the recipient's balance to the purchase total. If the balance is larger, the recipient's account is debited and the retailer's account is credited by the purchase amount.

The EBT Center then sends to the BTT a message indicating that the transaction is complete. The BTT prints a two-part receipt with the following information:

- date,
- time,
- terminal code,
- clerk's code (which is entered into the BTT by the clerk when the clerk's shift begins),
- store code,
- amount,
- balance in recipient's account,
- recipient's case number, and
- type of transaction (either purchase or refund).

The checkout clerk gives the recipient one copy of the receipt. The other copy is retained on a journal tape within the printer and serves as the retailer's record of the EBT transaction.

If the recipient's balance is less than the purchase total, the BTT displays the difference. The recipient may pay this amount in cash or remove some items from the purchase. In either case, the clerk re-enters the transaction with the new purchase total.

Credits also can be transmitted through the BTT. If a clerk accidentally charges a recipient more than the amount of the purchase or if a recipient returns items for a refund, the clerk carries out a procedure very similar to that for a purchase. This results in a credit to the recipient's account and a debit to the store account. Such transactions require a "management override"; they can be processed only by individuals authorized by the store management.

Manual Backup Purchase Procedures. If an electronic transaction cannot be processed at the EBT Center because both computers are down, a recipient may still purchase up to $35 worth of groceries each day.

To accomplish a purchase in this situation, the clerk first passes the BIC through the card reader and has the recipient enter his or her PIN. After the BTT verifies the PIN, the clerk telephones an operator at the EBT Center to request authorization for a manual EBT transaction. The clerk tells the operator the client's case number (printed on the BIC) and the amount of purchase. The operator checks the previous day's recipient balance report of remaining balances for all recipients. If the recipient's balance is sufficient, the operator gives the clerk an authorization code and places a temporary debit against the recipient's account. The checkout clerk records this authorization code, the case number, the purchase amount, and the store's identification number on a three-part manual sales form. The clerk retains one copy for the store, gives one copy to the recipient, and sends the third copy to the EBT Center. The EBT Center checks the amount on the manual sales form against the temporary debit, and credits the retailer's account.

If an electronic transaction cannot be processed because the retailer's BTT is not working, no PIN check is performed. The clerk calls the EBT Center to request authorization for a manual EBT transaction. Again, the

maximum daily authorization is $35. The operator checks the recipient's current balance before authorizing the sale and places a temporary debit against the recipient's account. The remainder of the process described above is then carried out.

Mobile vendors, such as home delivery dairies, do not have access to BTTs. To process sales to food stamp customers, these vendors follow the same procedures that other retailers use when their EBT equipment is not working. The only differences are that the mobile vendors phone in transactions after they return to their office and that they are not subject to the $35 limit on manual sales.

Providing Balance Information. In the ATP system, recipients merely count their remaining coupons to determine their benefit "balance". Keeping track of the electronic balance in the EBT system is much different.

In the EBT system, the EBT Master File at the EBT Center maintains information on each recipient's current balance. The EBT Center adds benefits to the recipient's account following the normal issuance schedule for Berks County. The recipient's purchases and refunds transmitted from a retailer's BTT are debited or credited to the accounts as they occur. In the event of system failure, the EBT Center uses the latest daily recipient balance report to maintain each recipient's current balance. Operators log manual transactions on a log sheet and maintain ongoing client balances.

Recipients may determine their current EBT account balance by any of three methods. First, every time the recipient makes a purchase, the BTT receipt shows the balance remaining after the purchase. Therefore, the most recent receipt usually shows the recipient's current balance. If the recipient's account has been credited with an issuance or debited with a manual sale since the last EBT transaction, however, the balance shown on the last receipt will be incorrect.

Second, recipients may check their current account balance by using a BTT. In addition to the regular terminals located at checkout counters, recipients may use either balance-only terminals located in 23 of the larger stores or a terminal located at the welfare office. To obtain a balance, the recipient or clerk passes the recipient's BIC through the card reader, and the recipient enters the PIN. After PIN verification, the operator presses a "Balance" key on the BTT to send a balance-request message to the EBT

Center. The Center sends the recipient's account balance to the BTT, which displays it.

As with purchase transactions, recipients have three chances to enter a correct PIN to obtain balance information. After three incorrect PIN entries, the BTT sends an unsuccessful-PIN-entry message to the EBT Center. If the EBT Center receives three such messages for an account during a single banking day, the system will accept no further balance inquiries for that account until the next day. This limit is imposed to prevent unauthorized persons from obtaining balance information. The balance information "lockout" does not keep the recipient from purchasing groceries; the system continues to accept food purchase transactions when the recipient enters the correct PIN at a BTT.

Third, recipients can learn their account balance by using a touch-tone telephone to initiate a call to the EBT Center. The recipient dials a special number provided for balance inquiries. The number connects to the EBT computer. When it is dialed, a synthesized voice answers, "Hello, please enter your case number" (in both English and Spanish). After the recipient enters the case number, the voice unit responds (again, in both English and Spanish), "Please enter your Personal Identification Number." The recipient enters the PIN, and the voice unit responds (in either English or Spanish, depending upon the recipient's preferred language), "Your current benefits are..."

RETAILER REDEMPTION OF FOOD STAMP CREDITS

In the ATP system, retailers redeem the food stamp coupons collected from recipients by counting their coupons, endorsing them, filling out a Redemption Certificate, and taking the coupons and the certificate to their local bank. The bank verifies the coupon amount with the retailer's Redemption Certificate and cancels all coupons with a bank stamp. After verifying the deposit, the bank credits the retailer's account. Crediting takes place either on the day of the deposit or the next banking day. If retailers do not bring their food stamp coupons to their bank each day, a delay occurs between the time of the sale and the time their bank accounts are credited.

The equivalent process in the EBT system is accomplished through an electronic transfer of funds to the retailers' accounts. Every afternoon, ex-

cept weekends and legal holidays, the EBT Center totals each retailer's transactions for the prior banking day, which runs from 2:00 PM to 2:00 PM. The Center translates the retailers' account numbers and total transaction amounts into the standard National Automated Clearing House Association (NACHA) format used by financial institutions for electronic funds transfers. An EBT Center operator then physically delivers a tape containing this information and identifying data for each retailer's bank to American Bank and Trust staff. AB&T requires that the delivery occur by 8:30 PM so that the bank can meet its Federal Reserve processing deadline of 12 midnight. (During the first seven months of operations, AB&T required the EBT delivery by 4:30 PM).

Each night, AB&T combines the EBT deposit information with similar information from other organizations needing to transmit payment data electronically through the Automated Clearing House (ACH) network. After extracting all EBT (and other) payments to be made to its own depository accounts, AB&T transmits the remaining deposit information to the Third District Federal Reserve Bank in Philadelphia. The Federal Reserve Bank debits its AB&T account by the sum of all retailer credits and distributes the retailer credits to the retailers' bank accounts. Thus, the system is designed to credit retailers' accounts within one banking day following an EBT sale.

BANK REDEMPTION OF FOOD STAMP CREDITS

With the ATP system, each retailer's bank redeems the food stamp coupons it receives. The bank ships the coupons, the Redemption Certificates, and a Food Coupon Deposit Document to the Federal Reserve System. The Federal Reserve Bank checks the amount of the coupons against the Food Coupon Deposit Document. After verification (which includes a check for counterfeit coupons), the Federal Reserve Bank credits the sending bank's reserve account and debits USDA's U.S. Treasury account maintained at the Federal Reserve Bank.

Bank redemption in the EBT system involves only AB&T rather than all of the retailers' banks. Reimbursement of AB&T's Federal Reserve account occurs when AB&T initiates a wire funds request through the Treasury Financial Communications System network. This request, which goes to the Federal Reserve Bank in New York, is made the morning after AB&T's account is debited by

the Federal Reserve Bank in Philadelphia. The New York Federal Reserve Bank draws down USDA's letter of credit with the United States Treasury which has been established for the EBT demonstration. It simultaneously credits AB&T for the sum of the previous day's retailer credits.

Finally, the Treasury provides USDA with a daily report of the amount of the drawdown on USDA's letter of credit. USDA also has an on-line capability to check its account activity at any time.

BENEFIT RECONCILIATION AND MANAGEMENT REPORT PRODUCTION

The ATP and EBT systems both generate reconciliation reports to ensure that benefits are distributed appropriately. In the ATP system, for example, one reconciliation compares the ATPs issued by the state welfare department to the ATPs accepted for coupons by issuance agents. Another reconciles the current inventory of coupons held by an issuance agent with previous inventory, additional coupons received, and benefits issued in exchange for ATPs. Reconciliation in the EBT system is more comprehensive because the system can track benefits from the state welfare department to the recipient to the retailer's bank account.

Account balances and benefit transfers are reconciled at numerous points in the EBT system. As described below, the major reconciliations occur when benefits are issued by PDPW, when accounts and daily EBT purchase transactions are balanced, and when retailer accounts are credited through the Automated Clearing House (ACH) funds transfer network. In addition, retailers may balance their sales receipts against deposits to their bank accounts, and retailer deposits are checked against drawdowns of USDA's letter of credit with Treasury.

Reconciliation of Issuances. The EBT Center and PDPW take two steps to reconcile benefit issuances to the EBT Center. First, daily transmissions from PDPW to the EBT Center are checked when received. The last record of each transmission contains totals for the number of cases and the dollar amount of benefits to be updated. The EBT Center rejects the transmitted file and notifies PDPW if the issuance records do not sum to either the case total or the dollar total. PDPW and the EBT Center immediately investigate and resolve the discrepancy.

For the second step, the EBT Center creates a file of all issuances placed in recipient accounts. This file has the same format as the tape files that PDPW produces when local issuance offices submit information on ATPs that have been redeemed. The state welfare department calls the EBT Center about twice each month to request that these files be combined, copied to tape, and delivered to Harrisburg. PDPW then combines the EBT tape with its own tapes to conduct a statewide reconciliation of all issuances.

Account and Transaction Reconciliation. The EBT Center reconciles all account balances and transaction activity each day after 2:00 PM. The Center produces a three-part System Daily Reconciliation Report using information in the EBT Master File and History File. The report covers recipient activity, retailer activity, and PDPW and AB&T activity.

The section covering recipient activity checks each account and the total for all accounts. It computes the recipient's current balance as follows:

$$\left.\begin{array}{l}\text{Unused benefits from prior months}\\ + \text{ Total issuances for the month}\\ - \text{ Total food purchases for the month}\\ + \text{ Total refunds for the month}\\ - \text{ ATP purchases for the month}\end{array}\right\} = \text{Current balance.}$$

The reconciliation compares this balance to the balance recorded in the EBT Master File. Manual sales that have not yet been reconciled against the EBT Center's copy of the manual sales form are subtracted from the "unused benefits" entry in the above equation. Once the manual sales form reaches the EBT Center, manual sales are included in the "total food purchase" entry.

The section checking retailer accounts and activity uses a similar formula:

$$\left.\begin{array}{l}\text{Total sales for the month}\\ - \text{ Total refunds for the month}\end{array}\right\} = \left\{\begin{array}{l}\text{Total deposits for the month}\\ + \text{ Total deposits on hold.}\end{array}\right.$$

Manual sales are included in the "total sales" entry after the EBT Center receives its copy of the sales form. "Deposits on hold" pertain only to newly authorized and equipped retail outlets that have not yet had their bank accounts listed in the ACH network. It takes about ten days after notification

to establish retailer, bank, and account numbers in the ACH network. The EBT Center holds any deposit credits until the account is established.

The reconciliation for recipients and retailers produces totals for the current day as well as for the month to date. Each day's total net debits (purchases minus refunds) for all recipient accounts are balanced against each day's total net deposits (sales minus refunds) for all retailer accounts.

The third section of the reconciliation report compares total funds received from PDPW to the sum of total funds remaining in recipients' accounts and total funds that have exited the system. Funds exit the EBT system either through transmission of deposits to AB&T or through conversion of benefits to ATPs.

EBT Center staff investigate and resolve any discrepancies discovered in the System Daily Reconciliation Report.

Deposit Reconciliation. When the EBT Center delivers the retailer bundle-up tape to AB&T, the bank checks the tape format and prepares a listing of all retailer accounts and deposit amounts on the tape. AB&T returns the tape and listing to the EBT Center after the deposit information is entered into the ACH network. The EBT Center verifies the accuracy of the deposit information by comparing the listing with its own records of store deposits for the day.

Other Reconciliation Activities. Once they enter the ACH network, deposits from the EBT demonstration are subject to the same reconciliation procedures as any other fund transfers. This process affects all transactions between AB&T, Federal Reserve Banks, the United States Treasury, and all banks holding retailer accounts.

Retailers may reconcile their EBT transactions and deposits by comparing their BTT transaction receipts with deposit information provided by their banks. Retailers also can call the EBT Center to inquire about daily transaction totals, although this is not a formal element of the system.

The Food and Nutrition Service reconciles retailer redemptions against drawdowns of its letter of credit at its Data Center in Minneapolis. Once a week, the EBT Center sends a tape to Minneapolis which details daily deposits to individual retailers. Weekly reports of drawdowns of the letter

of credit are passed by FNS from the United States Treasury to the Minneapolis Data Center.

The Food and Nutrition Service also reconciles monthly issuances in the EBT system. At the end of each month the EBT Center reports to FNS the total benefits issued to recipients, the total that recipients redeemed, and the total that retailers redeemed. The Pennsylvania Department of Public Welfare also submits information on the total benefits it authorizes each month. Comparison of these separate reports reconciles total monthly issuances.

The EBT Center, on request, can provide additional audit reports. These reports are generated from the History File, which records all transaction activity during the demonstration.

Management Reports. In addition to reconciliation reports, the EBT system produces a number of management reports. These include statistical summaries of monthly activities, system trouble reports, and logs of problems reported by retailers.

The reports serve two functions. First, by documenting the level and nature of system activity, they provide a description of what happened during the EBT demonstration in Reading, which is one of the primary purposes of the demonstration. Second, the reports allow PRC and food stamp authorities to monitor system activities and problems. They make it possible, for example, to identify households that are not using their food stamp benefits, to observe any sudden increase in unsuccessful PIN entries, and to identify irregular patterns of store redemptions.

Chapter Two

SYSTEM PROCESSING TIMES

Chapter Two

SYSTEM PROCESSING TIMES

An EBT system's computers and computerized files are its operational center. Nearly every system function described in Chapter One requires communication with the computers and access to files containing client and retailer account information or previous transaction activity. If the system cannot perform these functions rapidly, the entire performance of the system will be impaired.

2.1 GENERAL PERFORMANCE ISSUES

Two performance dimensions are important in assessing an EBT system's processing times. The first is the time the system requires to process "real-time" functions. (Real-time functions require the system to process information immediately and communicate the results back to system participants.) The second issue is how much time the system needs to process all other system functions.

It is important to distinguish between the two groups of functions because slow processing speeds for real-time functions generally have a greater negative impact on retailers and recipients than do slow processing speeds for other functions. A second reason is that the method by which the system processes the two groups of functions is likely to differ for most EBT systems. Thus, the two groups of functions differ both in the mechanics of their operation and in their potential impact on system participants.

SYSTEM FUNCTIONS REQUIRING REAL-TIME PROCESSING

In the Reading EBT system, five functions require real-time processing: purchase and refund transactions; querying account files to determine remaining balances or recent account activity; encoding retailers' and recipients' EBT cards; changing the current status of an account; and logging invalid-PIN and insufficient-balance messages on the system's transaction file. Although different EBT system designs could conceivably

require real-time processing for a different set of functions, the major identifying feature of these functions is that they involve immediate communication between system participants and the EBT system. System participants include not only retailers and food stamp recipients, but also county office workers and system operators who initiate account queries and immediate updates of file records.

One distinguishing characteristic of real-time processing functions is that they require only one or two account records to be accessed and processed. In addition, only small amounts of data must be processed to carry out the function. These characteristics clearly facilitate the rapid processing of real-time functions.

On the other hand, an EBT system has to process most real-time functions as they occur. More specifically, the system must handle purchase and refund transactions while the recipient waits at the grocery counter -- it cannot reschedule purchases to smooth out processing demands over the day. Control can be exercised over some real-time functions: for instance, card encoding could be scheduled for specific times, and account queries could be limited to specific periods. Such limitations, however, would reasonably be viewed as a reduction in the level of service the EBT system provides.

The time required to process real-time functions -- especially purchase and refund transactions -- is critical to both retailer and client acceptance of an EBT system. If processing times are too long, the resulting delays at checkout counters will cause customers to become impatient and, during busy periods, will lead to longer checkout lines. Retailers may be unwilling to accept reduced checkout productivity, especially in the highly competitive environment of the retail food industry. A study of the technical and economic feasibility of EBT systems concluded that retailer acceptance of such systems would be critical to their success.[1]

In assessing an EBT system's processing times, it is important -- but difficult -- to know what processing times retailers and clients will consider "too long." Retailers' attitudes about acceptable processing times

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[1]Report on the Feasibility of an Electronic Benefit Transfer System for the Food Stamp Program, Silver Spring, Maryland: Birch and Davis Associates Inc. and The Orkand Corporation, March 1982.

could be determined through interviews or a review of trade literature, but their statements may better reflect desired processing times than the minimum acceptable or tolerable processing times for an EBT system. Moreover, retailers in different segments of the retail food industry may have very different perceptions of what constitutes an acceptable processing time. Evidence from the Reading EBT demonstration suggests, for instance, that supermarket and convenience store managers were more concerned with the system's processing speeds than were managers of grocery stores.[1] Because an EBT system is likely to include a wider variety of store types than most commercial point-of-sale systems (which usually include only supermarkets and convenience stores), it is important to ascertain acceptable system processing times for these different market environments.

Instead of using retailers' statements as a guide for determining acceptable processing times in an EBT system, transaction times in existing commercial point-of-sale systems could be used as a benchmark. The number of POS systems currently operating in retail food outlets is still rather

SYSTEM FUNCTIONS NOT REQUIRING REAL-TIME PROCESSING

An EBT system performs many functions that do not require real-time processing. Key functions include the update of recipient account records after food stamp benefits are issued by the State Agency, the initialization and maintenance of client and retailer accounts, and the transmission of retailers' credited deposits to the system's clearinghouse bank. Furthermore, the system must perform numerous "housekeeping" functions on a regular basis. These latter functions may vary considerably depending upon the specific design of the EBT system. In Reading, the major housekeeping functions include: reconciling benefit amounts received from the State Agency with information on amounts transmitted; totalling retailers' credits ("bundle-up") in preparation for transmission to American Bank and Trust Company, the system's clearinghouse bank; reconciling daily credits to and debits from retailers' and clients' accounts; changing transactions incurred after 2:00 p.m. from "tomorrow's" transactions to "today's" transactions ("shift"); producing backup and archive files on a routine basis; and producing management reports detailing system activity.

The above functions usually require batch processing of large amounts of data. For instance, many of the functions require that all system account records be read and processed. System operators may have some flexibility in scheduling batch processing functions, but the extensive data to be processed often requires substantial amounts of computer processing time. Thus, although not as critical as the real-time functions, inefficient or slow processing of batch functions can create problems for the system. If the system performs these functions too slowly, system operators may have trouble meeting schedules for critical events such as posting new benefits to accounts or initiating funds transfers to retailers. Perhaps most importantly, slow batch processing may interfere with the system's processing of real-time functions if the same computers must process both types of functions simultaneously.

PROCESSING TIMES FOR ALL SYSTEM FUNCTIONS

An EBT system will probably need to process both real-time and non-real-time functions. Different hardware and software configurations for an EBT system may provide greater processing efficiency (and, hence, faster

processing speeds) for one type of function than the other. Thus, when designing an EBT system, the system developer must consider the relative processing efficiency of each potential hardware/software configuration for both types of functions. The impact of each potential configuration on overall system performance (including the processing of both real-time and non-real-time functions) then can be determined. If this exercise reveals that a particular hardware/software configuration would result in inadequate processing speeds for either type of function, then an entirely different configuration could be chosen. Alternatively, the developer may be able to modify the software of the original configuration to enhance the system's overall processing efficiency.

2.2 PERFORMANCE STANDARDS FOR PROCESSING TIMES

Because the processing time for purchase transactions has the greatest impact on store operations in POS systems, this issue gets the most attention in discussions of system performance. This does not mean that processing speeds for other system functions are unimportant. The general viewpoint has been, however, that as long as processing speeds for other system functions do not interfere with transaction processing and do not cause the system to miss operating deadlines, performance standards need not be specified. Of course, it is in the system operator's best interests to design a system which processes all functions in a cost-efficient manner.

STANDARDS FOR SYSTEM RESPONSE TIMES

Performance standards for transaction processing time are often stated in terms of system "response time." Response time is defined as the interval beginning when the retailer (or the customer) initiates a transmission from the point of sale and ending when the retailer receives a message from the system either approving or rejecting the transaction request. Time required to print a receipt for the customer is not included in response time. Communication times for messages to be transmitted between the retailer and the system, however, are included. Thus, response time is not just the time required by the system's computers to process the transaction.

The Food Marketing Institute (FMI), a trade organization representing the interests of member supermarkets in the United States, has established guidelines for issues dealing with EFT-POS systems.[1] These guidelines state that efficiencies can be gained in the checkout lane if response times range up to 10 seconds. For comparison, a study by FMI on cash and check handling times calculated the average time to accept cash during a transaction as 25.5 seconds. The average time to approve and accept a check during purchase was 65.2 seconds. When pre-transaction POS activities (i.e., card swipe and PIN entry) and post-transaction activities (i.e., receipt printing) are added to FMI's response time standard of 10 seconds, it appears that this organization is seeking a standard for EFT-POS transaction times that is at least comparable to cash payment times.

Site visits to commercial POS networks in Iowa and Florida indicate that response times within or approaching the 10-second guideline proposed by FMI are technically feasible. In Iowa, representatives of Hy-Vee Food Stores and Dahl's Foods, two major supermarket chains, stated that response times for POS transactions were normally 10 seconds or less. Although longer response times had occasionally been encountered during peak usage periods (usually Friday afternoons), even these occurrences had been reduced with a recent equipment upgrade by ITS, the operator of the Iowa POS network. Publix Supermarkets representatives in Florida said response times generally were a bit longer -- about 15 seconds.

The above response times do not include the time it takes the customer to swipe his or her debit card through a card reader and enter his or her PIN. Nor do they include the time it takes to print a receipt for the customer. Although no formal studies of total time for POS functions, (i.e., from card swipe through receipt printing) have been performed in either Iowa or Florida, Publix Supermarkets' representatives estimated total time at 22 to 23 seconds. In Iowa, the estimated time was approximately 20 seconds.

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[1] A Preliminary Look at the Voluntary Guidelines for EFT-POS Issues, EFT Conference of the Food Marketing Institute, September 1985.

EBT TRANSACTION TIMES IN READING

System processing times became a major concern in Reading when the EBT system began experiencing slowdowns early in the demonstration. Although subsequent modifications to the system improved system performance, response times remained longer than those estimated for the Iowa and the Florida POS systems. Further system improvements were not made because the demonstration nature of the Reading EBT system precluded the investment of greater resources to increase system processing speeds.

Data related to system processing speeds in Reading are available from two sources. Both PRC and Abt Associates conducted measurements at checkout counters to determine the time required to process EBT transactions. PRC also monitored processing speeds at the EBT Center. As described below, the two sets of measurements focused on slightly different aspects of the transaction.

PRC Measures of Processing Speeds. PRC separated the EBT activities related to transaction processing into five categories: dialing time, time to transmit and receive messages to and from the EBT Center, system queue time (i.e., time waiting for the system to begin processing a transaction), computer processing time, and time to print the EBT receipt. Time required to pass the EBT card through the terminal's card reader and to enter and verify the PIN was not measured.

Based on PRC's measures, the total time needed to complete the five activities ranged from 30 to 40 seconds (Exhibit 2-1). Although not documented by PRC, the variation in dialing time (from 6 to 12 seconds) presumably reflects differences in stores' telephone service. Dialing time is substantially greater for stores whose telephones use rotary dialing than for stores with touch-tone service.

Response time estimates in Iowa and Florida did not include time to print a receipt. The six seconds for receipt printing must be subtracted from PRC's measures to yield a comparable response time estimate. The resulting estimate is 24 to 34 seconds, or about twice as long as the estimated 15-second response times in Florida.

Exhibit 2-1

TRANSACTION PROCESSING TIMES IN READING, IN SECONDS

Activity	Low Value	High Value
Dialing the computer	6	12
Transmitting messages between terminal and computer	6	6
Queue time	8	12
Computer processing time	4	4
Receipt printing	6	6
Total time	30	40

Source: Letter from Mr. Harish Kathpal of PRC to Ms. Carol Olander of FNS, dated April 29, 1986.

Abt Associates' Measures of Transaction Times. The checkout observations conducted by Abt Associates were designed to evaluate the EBT system's impacts on overall checkout productivity. The observations focused on two time measures: payment time and total time to complete the purchase (total transaction time). The payment time measure is of greater interest here because it is more directly related to system processing speeds.

Payment time is defined to begin when the clerk announces the purchase total to the customer. For cash and food stamp coupon purchases, payment time ends either with the closing of the cash drawer or with the clerk's presentation of a sales slip to the customer, whichever occurs last. For EBT purchases, payment time ends with the clerk's presentation of the EBT receipt. Unlike PRC's measures of processing speeds, the payment time measures include the time to pass the EBT card through the terminal's card reader and the time to enter and verify the customer's PIN. They also include time spent resolving problems (e.g., calling the EBT Center for assistance if the receipt was not printed) and time spent on activities like grocery bagging if these activities occurred prior to the presentation of the EBT receipt.

The stopwatch observations took place during two four-month periods in 1985: February through May (denoted as Wave 2) and September through December (Wave 3). The Wave 2 observations started just after the entire demonstration caseload began using the EBT system and coincided with a period when the system was experiencing problems with slowdowns and downtime. Wave 3 observations occurred near the end of the demonstration when most major system problems had been corrected.

Within each of the two observation periods, observers scheduled their store visits during the days immediately following each month's benefit issuance. The intent was to maximize the number of observed EBT and food stamp coupon purchases. This schedule, however, also meant that the system's impacts on checkout productivity were measured during periods of peak system usage, when system response times might be expected to be slowest. Thus, the observed EBT transactions do not represent system performance throughout the months covered by the observation periods. Because EBT transaction activity is highest immediately after issuance, however, the observed transactions do reflect system performance during this critical peak-usage period.

Observations occurred in a sample of 30 demonstration stores and 10 stores in nearby Allentown. The Allentown stores were included to observe purchases using food stamp coupons. Both the Reading and the Allentown samples were split into three equal-sized subsamples -- supermarkets, small- to medium-size grocery stores and convenience stores -- to reflect the diversity of operating environments in which EBT transactions take place.

Several factors affect total payment time, including the number of items purchased, the mode of payment (i.e., cash, food stamp coupons, EBT card), and whether or not food stamp purchases also include non-eligible items requiring partial cash payment. In addition, special problems can increase payment time for EBT transactions. These problems include system slowdowns, delays in getting through to the system's computers, incorrect use of the store's EBT equipment, and problems entering a valid PIN. To measure the effect of using the EBT system on the time to pay for groceries, regression analysis is used to estimate the individual contributions of each factor to total payment time (with a single variable indicating the occurrence of an EBT-related problem).[1]

Because EBT purchases might vary from other purchases in a systematic fashion (e.g., in the number of items purchased), the estimated regression coefficients are used to compute the average payment time for a "typical" EBT purchase, where the "typical" purchase has the average number of items for all EBT purchases, the average likelihood of EBT problems, and the average likelihood of being a card-only transaction rather than a card-and-cash transaction. The regression coefficients are then used to estimate expected payment times for the typical EBT purchase if the customer had paid with cash or with food stamp coupons (alone or in combination with cash). The effect of using the EBT card is estimated by examining the difference in expected payment times for the three modes of payment.

Exhibit 2-2 presents the results of the analysis. During Wave 2, the average payment time for the typical EBT purchase in supermarkets was 156 seconds. The average payment times for typical EBT purchases in grocery stores and convenience stores were each about 85 seconds. The longer payment

[1]For a detailed discussion of the regression analysis, see Hamilton, op. cit.

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Exhibit 2-2

AVERAGE PAYMENT TIMES, IN SECONDS

WAVE 2			
Payment Mode	Supermarkets	Grocery Stores	Convenience Stores
EBT Card	**155.6**	**84.9**	**85.4**
Cash	**46.9**	**23.4**	**19.5**
Card minus cash	**108.7*****	**61.5*****	**65.9*****
Coupon	71.0	29.7	24.4
Coupon minus cash	24.1***	6.3	4.9
EBT minus coupon	84.6***	55.1***	60.9***

WAVE 3			
Payment Mode	Supermarkets	Grocery Stores	Convenience Stores
EBT Card	**78.2**	**61.5**	**58.0**
Cash	**41.2**	**21.2**	**20.0**
Card minus cash	**37.0*****	**40.3*****	**38.1*****
Coupon	78.2	25.7	25.5
Coupon minus cash	37.0***	4.5	5.5*
EBT minus coupon	0.0	35.8***	32.5***

Notes: Statistical significance: *, p<.05; ***, p<.005.

Source: Checkout counter observation data, Waves 2 and 3.

time in supermarkets reflects both the larger number of items included in a typical order and longer delays, on average, when system-related problems occurred in supermarkets.

If cash had been used to pay for these EBT purchases, the expected average payment times would have been 47 seconds in supermarkets, 23 seconds in grocery stores and 20 seconds in convenience stores. Thus, as shown in the exhibit, using the EBT system increased the average payment time in supermarkets by nearly 109 seconds. In grocery stores and convenience stores, the EBT system added somewhat more than one minute to total payment time. All three estimated effects are statistically significant. As discussed later, system slowdowns and other EBT-related problems contributed substantially to these large increments in total payment time.

The exhibit also shows that EBT payment times during Wave 2 averaged 55 to 85 seconds longer than payment times for similar purchases using food stamp coupons. Again, system problems contributed to these statistically significant differences in total payment time.

During Wave 3, the average payment times for cash and food stamp coupon purchases were similar to the estimated times in Wave 2 (again based on expected times if cash or coupons had been used in typical Wave 3 EBT purchases). The estimated payment times using the EBT card, however, are 78 seconds in supermarkets, 61 seconds in grocery stores and 58 seconds in convenience stores, a substantial reduction from the Wave 2 estimates. Two factors explain these reductions. First, as discussed later in this chapter, normal system operating speeds improved between the two waves when PRC implemented several modifications to system software. Second, the frequency of system problems declined somewhat, and the duration of these problems declined substantially.[1] Nevertheless, payment times for EBT transactions in Wave 3 were still 37 to 40 seconds longer than cash payment times.

The Wave 3 estimates for total EBT payment times are 18 to 38 seconds longer than PRC's upper-bound estimate of 40 seconds. As discussed

[1]See Hamilton, op. cit. for a description of the frequency and duration of system-related problems.

earlier, our payment time estimates include the time to enter and verify the PIN and time to take care of any system problems which may have occurred.

EBT payment times in supermarkets in Wave 3 required no more time than similar purchases using food stamp coupons. In grocery stores and convenience stores, EBT payment times were 32 to 36 seconds longer. The likely explanation for these differential effects is that purchase size affects coupon payment times more than EBT payment times, as customers count out the appropriate number of coupons to pay for the purchase. Because purchases in supermarkets are larger than purchases in other stores, the time required to count out coupons offsets more of the EBT system's effects on payment times.

The payment times for EBT purchases in Exhibit 2-2 include the delays resulting from system-related problems. As such, they represent our best estimates of the actual average time required during the demonstration to pay for groceries using an EBT card. Payment times would be less, however, if an EBT system operated with fewer problems. To determine the likely impact of a trouble-free EBT system on payment times, the previous analysis was rerun using only "routine" transactions. "Routine" transactions are defined as those that (1) involve no problems with the EBT system, (2) do not involve any other unusual circumstances or events, (3) are not in the observer's judgment unusually long for some reason not related to the EBT system, and (4) do not have an average price per item of less than $.10.

Exhibit 2-3 presents the results of the analysis of payment times based only on routine transactions. The payment times for cash and for food stamp coupon purchases differ from those in Exhibit 2-2 because the deletion of problem EBT transactions changes the profile of a "typical" EBT transaction.

Comparing Exhibits 2-2 and 2-3, the average payment times for routine EBT purchases are less than the average payment times for all EBT purchases. Because system problems were more severe during Wave 2, the reduction occurs mostly during this wave. For instance, payment times for routine EBT purchases in Wave 2 were 37 to 49 seconds longer than similar cash transactions, compared to the 62- to 109-second increments presented in Exhibit 2-2. During Wave 3, the average payment times for routine EBT purchases were 31 to 36 seconds longer than similar cash purchases, compared

Exhibit 2-3

AVERAGE PAYMENT TIMES FOR ROUTINE TRANSACTIONS, IN SECONDS

WAVE 2			
Payment Mode	Supermarkets	Grocery Stores	Convenience Stores
EBT Card	**86.9**	**63.2**	**55.5**
Cash	**38.3**	**24.0**	**18.9**
Card minus cash	**48.6*****	**39.2*****	**36.6*****
Coupon	65.0	32.5	23.3
Coupon minus cash	26.7***	8.5**	4.4*
EBT minus coupon	21.9***	30.7***	32.2***

WAVE 3			
Payment Mode	Supermarkets	Grocery Stores	Convenience Stores
EBT Card	**70.1**	**57.0**	**56.5**
Cash	**39.1**	**20.7**	**20.4**
Card minus cash	**31.0*****	**36.4*****	**36.1*****
Coupon	72.2	25.1	26.6
Coupon minus cash	33.1***	4.5	6.2**
EBT minus coupon	-2.1	31.9***	29.9***

Notes: Statistical significance: *, p<.05; **, p<.01; ***, p<.005.

Source: Checkout counter observation data, Waves 2 and 3.

to the 37- to 40-second increments in Exhibit 2-2. Despite these reductions, however, each increment in payment time remains statistially significant.

Even after deleting non-routine transactions, payment times using the EBT card remained greater than expected payment times for coupon purchases. During Wave 2, an additional 22 to 32 seconds were required to pay for groceries using the EBT system rather than coupons. In Wave 3, EBT payment times in grocery stores and convenience stores required about 30 to 32 seconds longer than expected payment times using coupons. Payment times for routine transactions in supermarkets in Wave 3 required no more time than payment times for similar coupon purchases.

In summary, the checkout counter observations indicate that PRC's estimate of 30 to 40 seconds for system processing activities did not account for transactions in which system-related problems increased total payment time. When these problem transactions and the time to enter and verify the PIN are considered, EBT payment times varied from 85 to 156 seconds in Wave 2 and from 58 to 78 seconds in Wave 3.

When compared to similar transactions involving cash payment, the EBT system added from 61 to 109 seconds to the average Wave 2 purchase, and from 37 to 40 seconds to the average Wave 3 purchase. Although the analysis indicates that a trouble-free EBT system would have somewhat less of a negative impact on payment times, the estimates provided above reflect the actual impacts on retailers' checkout operations during the demonstration. These incremental time estimates are quite high compared to industry desires that a POS system reduce overall payment times. Nevertheless, although retailers did complain about system processing speeds, they were generally very pleased with the EBT system, suggesting that the system's processing speeds were at least tolerable. Of course, the Reading EBT system substitutes the EBT payment mechanism for coupon payments rather than cash. Because coupon transactions take longer than similar cash transactions, retailers in Reading may have used a less stringent standard when evaluating the EBT system's processing speeds.

2.3 PROBLEMS ENCOUNTERED IN THE READING EBT SYSTEM

The Reading EBT system experienced substantial problems related to the speed with which the system handled both real-time and batch functions.

During the course of the demonstration, PRC and FNS spent considerable time determining the extent of the problems, diagnosing their cause, and considering and implementing modifications to improve processing performance. As evidenced by the data on checkout times above, these modifications were successful in reducing the severity of transaction processing problems. Even after the modifications were implemented, however, system response times for purchase transactions still exceeded actual response times achieved by other POS systems.

In part, the demonstration nature of the Reading EBT system kept it from achieving better response times. Some possible modifications for improving system processing times were deemed too expensive or too time consuming to warrant implementation in a demonstration setting. The Pennsylvania Department of Public Welfare plans to enhance the system to improve processing speeds after it takes control of the Reading system.

SLOW PROCESSING OF REAL-TIME FUNCTIONS

The major real-time function in the Reading EBT system is the processing of purchase transactions. The system encountered several different problems affecting the time to complete these transactions. Especially at the beginning of the demonstration, retailers and recipients sometimes had problems operating the system. Equipment problems occasionally caused delays, and store terminals sometimes could not access the system. Finally, slow internal processing speeds in the EBT Center computers increased the time required to complete a purchase.

This section discusses problems which affected the system's internal processing speeds. Subsequent chapters address the other problems mentioned above.

Serial Processing. To ensure database integrity, PRC designed the EBT system to process purchase transactions serially. That is, all processing functions which needed to access a retailer or recipient record on the system's Master File had to pass through a central software module (DBAPP). No other function could access Master File records until the first access was completed. This design protected the integrity of the Master File in the event of system failure. If the system failed, the Master File could easily

be returned to its status immediately preceding the failure without losing track of any transactions interrupted by the failure.

One problem with this serial processing design was that several batch programs that needed access to the Master File (but did not change any data within the file) also had to pass through the central software module. Thus, whenever a batch program was being run, it competed with purchase transactions for access to the Master File. PRC changed the DBAPP software module in March 1985 to allow limited parallel accessing of the Master File. All functions which needed to change records in the file still had to pass through the central software module. The software change, however, allowed three lengthy batch programs (Shift, Daily System Reconciliation, and End-of-Month reports) which needed only to read the Master File to do so without passing through the DBAPP queue. This redesign improved the processing of purchase transactions (by reducing queue time for access to the Master File) without degrading the ability of the system to recover the database in the event of a system failure.

At the same time that the DBAPP software module was changed, PRC also modified a second software module, TIMAIN. TIMAIN routes transaction messages from store terminals to the incoming queue of DBAPP. Prior to the change, TIMAIN waited for a message from DBAPP indicating that a prior transaction had been processed before sending the next transaction message to the queue. After the change, TIMAIN routed transaction messages to the DBAPP queue without waiting for a return message. This change acted to keep the DBAPP queue from emptying out during periods of heavy transaction activity. By maintaining a steady flow of transaction requests in the DBAPP queue, the system avoided delays incurred while DBAPP waited for the next transaction message.

Competition for System Resources. To reduce competition between the processing of purchase transactions and batch programs, PRC also rescheduled the time when the daily Bundle-Up program was run. Although this particular batch program requires only about 30 minutes to run, in the early months of system operations it had to be completed between 2:00 PM and 4:30 PM to meet American Bank and Trust Company's deadline for accepting retailer deposit information. Because many EBT purchases also occur during these afternoon hours, response times suffered when the Bundle-Up program was run. In April,

American Bank and Trust changed its processing deadline for EBT system retailer data to 8:30 PM. This gave PRC more flexibility to schedule bundle-up at times when purchase transaction volume was low.

Tandem Configuration. Another design factor that originally impaired processing times was the tandem configuration of the system's computers. To reduce the frequency and length of time the system might be unavailable after a system failure, two computers, each with its own Master File, were linked together. If the primary computer failed, processing could be transferred quickly to the secondary computer. A desire to maintain a high level of overall system reliability led to this design configuration.

The original tandem design required that the two copies of the Master File be updated simultaneously. Thus, when the primary computer received a purchase transaction message, it first updated its copy of the file and then passed a message to the secondary computer telling it to update its copy of the Master File. The primary computer then waited to receive a message from the secondary computer that the second Master File was updated before sending a message to the store terminal that processing was complete. This design lengthened total processing times by adding the secondary computer's processing time (and inter-computer communications time) to the primary computer's processing time.

When slow processing speeds first began to affect system performance in November 1984, operators at the EBT Center opted to decouple the two computers during peak transaction periods to improve response time. They would update the secondary Master File periodically (rather than simultaneously) by logging completed transactions to a diskette storage device and later using the diskette to bring the secondary Master File up to date. This change, however, affected system reliability; if the primary computer failed, processing could not be transferred to the secondary computer until its Master File had been updated with recently completed transactions. This updating usually took about 30 minutes, during which time no EBT transactions could be processed.

[redacted]

one of its computers. In June 1985, PRC changed the configuration of the system's computers by adding a large disk storage device (a 200 megabyte cache disk) to the system. With this addition, only one copy of the Master File needed to be continually updated. Both the primary and the secondary computer could access this single file, so if the primary computer failed, processing could be transferred to the secondary computer without delay. To protect the system in the event the Master File on the new device could not be accessed, a second copy of the Master File continued to be maintained on the secondary computer. The second copy was updated periodically rather than simultaneously.

The communications link between the two computers also may have caused problems with processing speed. In an independent review of the EBT system design, an outside consultant stated that this link (a 9600 baud serial inter-processor communications link) was inappropriate, and that it added four to five seconds to processing times when the system operated in a tandem configuration. The consultant suggested a local communications link which could directly access the secondary database. Responding to the independent review, PRC challenged the estimate of increased time. Once the system configuration was changed to access only one copy of the Master File, however, the issue of inter-computer communications times became moot.

Time-out Periods for Store Terminals. The original design for the Reading EBT system incorporated a one-minute time-out period for all store terminals. After dialing the system's computers to initiate a purchase transaction, store terminals would automatically disconnect if the system did not respond with an authorization message within 60 seconds. Such time-out periods are designed to prevent a store terminal from tying up a communications line to the system if processing for a particular transaction is delayed. The POS systems in Iowa and Florida also incorporate time-out periods.

Time-out periods should be set for sufficiently long time intervals that transactions are not routinely interrupted by the automatic disconnect. Not only do such disconnects require retransmission of the original purchase transaction message, they impose additional processing requirements for the original transaction request. To illustrate, suppose the Reading system processed a transaction message and updated the retailer's and the recipient's

account balances on the Master File, but failed to send a message back to the terminal before 60 seconds elapsed. Because the entire transaction process was not completed, the system would have to go back to the Master File and reset the account balances to their level prior to the original transaction request. Resetting the account balances effectively doubles the amount of required system processing. When the retransmission of the original request is considered, total processing requirements are nearly triple that of a transaction which is not interrupted by a time out.

When the Reading EBT system began to encounter slow processing of purchase transactions during peak-volume periods, store terminals began to time out with increasing frequency. Because the time outs increased processing requirements, they exacerbated the system's existing processing problems. PRC therefore changed the time-out period in the terminals of the five busiest stores in Reading from one to three minutes. They implemented this change in March 1985. Because other system improvements also were implemented near this time, it is impossible to isolate the impact of this particular change on system processing speeds. Nevertheless, PRC noted a marked decrease in the number of time outs afterwards.

SLOW PROCESSING OF BATCH FUNCTIONS

The EBT system runs four major batch programs on a daily basis: Shift, Bundle-Up, Daily System Reconciliation, and Update. The Shift program is run after midnight; it reallocates transactions processed after 2:00 PM from "tomorrow's" transactions to "today's" transactions. This reallocation is needed for the next day's Bundle-Up program, which sums "today's" credits to retailers for entry into the ACH network. The Daily System Reconciliation checks to see if all flows of funds through the system are in balance. The Update program posts daily benefit issuances to recipients' accounts. Although Update is run each business day, it has a lengthy run time only on regular monthly food stamp issuance days. On other days only a small number of supplemental or prorated issuances are processed.

In addition to the daily batch programs, several batch programs are run after the end of each month to generate management reports on system activities.

As described below, problems with the design of software modules and with the system's programming language led to slow processing of batch functions in the Reading EBT system.

Software Problems. The major software problem related to the processing of batch programs has already been discussed. Prior to the changes in the DBAPP module, all batch programs passed through DBAPP to read a record in the Master File. Because most of these programs read all records in the Master File, significant delays occurred. After PRC changed DBAPP to allow the Shift, Daily System Reconciliation, and End-of-Month programs to read the Master File without passing through the DBAPP queue, batch processing times decreased dramatically, as shown in Exhibit 2-4.

Exhibit 2-4

APPROXIMATE PROCESSING TIMES FOR BATCH PROGRAMS

Program	Before DBAPP Change	After DBAPP Change
Shift	5 hours	30 minutes
Bundle-up	20 minutes	20 minutes
Daily System Reconciliation	4 hours	30 minutes
Update	4-5 hours	4-5 hours
End-of-Month reports	24 hours	8 hours

PRC did not change processing of Bundle-Up because this program requires only about 20 minutes to run. The short processing time occurs because only retailer records are accessed for this program. Processing of the Update program was not changed because the EBT Center normally runs this program early in the morning -- when transaction processing demands are low.

Programming Language Problems. In addition to the DBAPP software issue, an outside consultant criticized PRC's choice of PL/1 as the programming language for the Reading EBT system. According to the consultant, PL/1 is a very inefficient language for the system's IBM Series/1 computers. Programs written in PL/1 take longer to run on the Series/1 than identical programs written in other programming languages, thereby slowing system processing for both real-time and batch functions. The slower processing speeds arise because the system requires more time to read and interpret instructions written in PL/1 than similar instructions written in other programming languages.

PRC did not disagree that other programming languages could have been more efficient for the Reading EBT system. One very efficient language which both PRC and the consultant mentioned is EDL (for Event Driven Language). PRC chose PL/1 as the programming language for the system's software, however, for three reasons. First, they recognized that EDL was not an approved language for federally funded computer applications. Second, languages like EDL are not very proficient at file management and data manipulation. Third, PL/1 software code is relatively easy to write and debug. In addition, an IBM engineer familiar with the Series/1 recommended PL/1 to PRC as a suitable programming language. Ironically, after the basic design of the system's hardware and software had been completed, PRC learned that PL/1 also is not a federally approved programming language. Before actual software development began, PRC sought and obtained a federal waiver to use PL/1 for the Reading EBT system.

The issue of the appropriateness of PL/1 emerged after PRC implemented the EBT system in Reading and problems with processing speeds became evident. Changing to a different programming language would mean completely rewriting and retesting the system's software. Because the system was meeting its basic objective of handling purchase transactions at the point of sale, no serious consideration was given to changing the system's programming language during the demonstration. Instead, PRC implemented other system modifications described in this and subsequent chapters to improve system performance.

2.4 POTENTIAL PROBLEMS IN OTHER EBT APPLICATIONS

The previous section documented several features of the Reading EBT system which resulted in problems with transaction processing speeds. Without adequate design review and system testing, similar problems could impact the performance of EBT systems implemented elsewhere. In addition, other factors -- which caused no major problem in Reading -- might impair transaction times in other EBT systems. These other potential problem areas, discussed below, should be reviewed during system design and testing.

REROUTING OF EBT TRANSACTIONS

In the Reading EBT system, all purchase transactions were communicated to the EBT Center and processed there. In commercial POS networks, debit transactions are often communicated to what is known as a "switch." Because the customers making the transactions may have their accounts established at various financial institutions, the switch does not normally process any debit transactions. Instead, based on information contained in the transaction message, the switch reroutes the transaction message to the appropriate financial institution. The financial institution checks the purchase amount against the client's remaining account balance (or against an authorized daily limit) and sends an authorization message back to the switch. The switch then transmits the message back to the point of sale.

Discussions with network operators in Iowa and Florida indicate that financial institutions vary in the speed with which they process transaction messages. Indeed, these networks have found it necessary to impose financial penalties on institutions if they do not process transactions within specified time limits. The time limit in Iowa is currently six seconds. In Florida, financial institutions must process 95 percent of their transactions within 15 seconds to avoid penalties. Both networks offer "stand-in" processing services to financial institutions which cannot meet these performance standards. For the network to perform stand-in processing, the financial institution must provide lists of authorized accounts and maximum daily limits on purchase amounts. If an account becomes overdrawn under these circumstances, the financial institution assumes liability.

If future EBT systems are integrated into existing commercial POS networks, the State Food Stamp Agency could either process its own food stamp

transaction messages or negotiate with a local financial institution or vendor to provide this service. Under either option, the State Agency would have to assure itself that transaction processing speeds would meet the network's performance standards.

TIME TO COMMUNICATE MESSAGES

A second area of potential response time problems is telecommunications. In the Reading EBT system, all calls between stores and the EBT Center during the demonstration were local calls, and transaction messages were not rerouted through a switch. If long distance calls are required in other EBT systems, communications times will increase. Similarly, if one or more switches are present in the design, each switch will add about one second to total response time.

These increased communications times can be offset by the use of dedicated telephone lines or by store terminals which transmit messages faster. Dedicated lines, which were not used in Reading, can improve response times considerably by eliminating the time required to dial up a switch or an EBT Center. For stores with touch-tone service, about six seconds in dial-up time could be eliminated from total response time. In stores with rotary service, from nine to 15 seconds could be eliminated. Potential time savings from the use of terminals which transmit at higher speeds are considerably smaller. If the Reading demonstration had used such terminals, the estimated time savings would have been about two to three seconds. Dedicated lines and higher-speed transmissions, however, are more expensive than the slower alternatives. The tradeoff between response time and operating costs must therefore be considered carefully.

2.5 RECOMMENDATIONS WHICH SHOULD IMPROVE PROCESSING PERFORMANCE

Future applications of EFT and POS technologies to the issuance of food stamp benefits may involve system designs and equipment configurations different from the Reading EBT system. Thus, it is impossible to identify in detail all the possible problems that could affect processing speeds in future

systems. Nevertheless, based on the experience in Reading, several recommendations can be made to reduce the likelihood of problems occurring:

1) Specify performance standards for system response times prior to system design.

FNS did not specify performance standards for system response time in the Reading EBT demonstration. Few POS systems were operating when the Reading system was designed, and FNS determined that the available information was not sufficient for setting performance standards. The lack of standards however, created several problems for both PRC and FNS. PRC had no explicit goals to guide system design and, once the Reading EBT system was implemented, FNS had no explicit measures against which to evaluate the adequacy of system performance. This left room for disagreement between FNS and PRC as to whether or not the system was operating at an acceptable level of performance.

The development of EBT-like POS systems has now progressed to the point that reasonable performance standards for response times can and should be specified before a new EBT system is designed. Such performance standards can eliminate much of the ambiguity that surrounded the assessment of the Reading system's performance. Approaches for specifying response time standards are discussed below. When specifying performance standards, it should be realized that system costs may increase as more stringent standards are specified. It is also the case, however, that costs for a given level of performance should decrease in the future as the technology for EBT systems improves. EBT systems which are integrated with commercial POS systems also may be able to take advantage of the high performance levels offered by these systems, while keeping costs at a reasonable level. A State Agency, therefore, should consider the various levels of performance which are technically feasible and weigh the costs and performance advantages of each potential performance standard.

In its simplest form, a performance standard for system response time would state that total response time for EBT transactions cannot exceed a specified number of seconds. Because EBT technologies will likely improve over time, an actual performance standard is not recommended here. The information contained in this report, however, can serve as a starting point for determining an appropriate standard. The key benchmark figures are: 24-

28 seconds, which PRC estimated as the average response time after the system's improvements; 8-15 seconds, reported for the Iowa and Florida POS systems; and 10 seconds, mentioned in the FMI guidelines.

A simple response time standard would be deficient in at least two respects. First, response time -- as defined in Section 2.2 -- does not measure the full impact of an EBT transaction on checkout times at grocery stores. Second, the standard does not account for events which may be beyond the control of the system developer.

Response time does not measure the full impact of an EBT transaction on retailers because it does not include the time it takes recipients to enter their PIN and the time required to print a receipt. Because retailers care most about how an EBT system affects total time in the checkout lane, a performance standard should be specified in terms of total transaction time. It is entirely appropriate to include PIN entry and receipt printing times in a performance standard; these times can be affected by the system design and by choice of equipment.

The system developer cannot, however, control all factors which affect total transaction time. Recipients may occasionally have problems entering their PINs, and communication times between the store terminal and the system can sometimes be affected by transmission line problems within the telephone network. To account for these possibilities, a more flexible performance standard might be appropriate. For instance, instead of stating that total transaction time must always be less than a specified number of seconds, the standard could specify that 95 percent of all transactions must be completed within the time standard.

2) Estimate expected transaction volumes and size the system accordingly.

The number of EBT transactions to be processed, especially during periods of peak volume, is a critical parameter to be incorporated in the design of an EBT system. If the number of EBT transactions is underestimated, system processing speeds may fall below the level needed to meet standards for total transaction time. It is of paramount importance, therefore, that expected transaction loads on a new system be carefully estimated.

Expected transaction volumes affect communications and system file capacity issues as well as system processing times. These capacity issues are described in detail in Chapter Three, and further discussion of how a system should be sized to meet expected transaction volumes is presented in that chapter (pp. 63-68).

3) Design system operations, insofar as possible, to reduce peak-load processing requirements.

Peak-load processing requirements can be reduced in two ways. Peak demands for purchase transactions can be reduced, or batch processing functions can be scheduled for off-peak hours.

As will be documented in Chapter Three, peak transaction demands in an EBT system tend to occur immediately after food stamp benefits are issued. Peak transaction demands on a system can be contained, therefore, by issuing food stamp benefits on multiple days rather than a single day of the month. Benefit issuance schedules, of course, are set by food stamp authorities. As authorized by the Food Security Act of 1985, State Agencies may wish to consider staggering benefit issuance throughout the month to reduce peak loads on an EBT system. Evidence of the impact of staggered issuance on peak loads in the Reading EBT system is presented in Chapter Three.

If batch processing competes with transaction processing for computer resources, peak-load requirements can be reduced by scheduling batch processing functions for off-peak hours. This will allow all computer resources to be allocated to transaction processing during peak hours, reducing the likelihood that peak volumes will impair system performance.

4) Select a hardware and software configuration which can efficiently handle system processing requirements.

Given the Reading demonstration's hardware and software problems, selecting appropriate hardware and writing efficient software are obviously important design decisions. The system developer should carefully consider all system processing requirements and match these requirements against the processing capabilities of available computer hardware. Furthermore, the software configuration chosen for the system should take advantage of any

inherent processing strengths offered by the hardware and bypass -- if possible -- any inherent limitations. The programming language selected also should support the efficient processing of system functions.

5) Test the system thoroughly prior to implementation.

A system developer must design an EBT system to meet specified performance standards for total transaction times. Actual performance levels, however, do not always meet planned performance levels. To avoid this, the system developer should thoroughly test a prototype of the system to ensure that performance standards will be met. This testing should occur well in advance of the system's planned implementation date. Early testing will provide time to incorporate system design improvements if performance levels during testing fall short of performance standards.

System testing should include two phases. First, the time required by the prototype to process a single purchase transaction should be carefully monitored. Second, the prototype should be tested under expected peak processing demands to ensure that transaction times do not increase beyond performance standards.

When testing the time required to process a single purchase transaction, the developer should measure how much time is required to complete each step of the transaction. In the Reading system, these steps included: card swipe and PIN entry; PIN verification at the store terminal; assembling a transaction message at the store terminal for transmission to the EBT Center; dialing up a line to the system's computers; communicating the transaction message to the system's computers; internal processing by the system's computers; communicating an authorization message back to the store terminal; and printing a receipt for the transaction. By measuring the time to perform each step of the transaction, the developer can identify the source of any unexpected delays in total transaction time. If transaction performance standards are exceeded, the source of unexpected delays will indicate where processing improvements are needed.

Even if a system prototype processes a single purchase transaction within the system's stated performance standards, this level of performance might not be maintained under peak processing demands. To ensure that peak

loads can be processed within transaction time performance standards, the prototype should be subjected to expected peak processing loads. This should include batch processing loads if batch processing functions must be handled by the system during peak-transaction periods.

In the absence of an actual operating environment, peak transaction loads on a prototype system must be simulated. One option for performing such a test is to program a separate computer to generate a high volume of transaction messages to the prototype. In performing such a simulation, the test environment should replicate the expected operating environment as much as possible. For instance, communications times between the two computers may not reflect expected communications times in the field unless a communications delay is built into the test. Alternatively, having the two computers communicate over telephone lines rather than by a direct communications link may better reflect actual operating conditions after system implementation.

Chapter Three

SYSTEM CAPACITY

Chapter Three

SYSTEM CAPACITY

Unlike processing times, EBT system capacity is not directly observed by retailers or food stamp recipients. Nevertheless, limited system capacity can lengthen both the time it takes a store terminal to access the system and the time the system takes to process a purchase transaction. Capacity also can affect how efficiently the system carries out its accounting functions after a day's transactions have been logged into the system. The capacity of an EBT system, therefore, is an important factor affecting the system's overall performance.

3.1 GENERAL PERFORMANCE ISSUES

An EBT system has three major elements in which limited capacity can seriously reduce system performance: communications, processing throughput, and file size and organization. Insufficient capacity in any one of these three elements can create bottlenecks during system processing, slowing response time or creating other processing difficulties. The following sections describe general performance issues associated with each design element.

COMMUNICATIONS

System performance will be inadequate if the capacity of the system's communication facilities is insufficient. In an on-line, real-time system like the Reading EBT system, transaction messages must be transmitted over telephone lines to the system's computers as purchases are made at retail outlets. Regardless of how fast the system's computers can process a single transaction, transaction messages cannot get to the system unless there is an open telephone line to transmit the message. Thus, limited communication capacity (indicated by the lack of available open telephone lines to the computer) will lead to delays in purchase transactions.

Computer systems can accept messages from multiple telephone lines at the same time. In determining needed communications capacity, therefore,

the question is how many telephone lines to the computer must be available to handle transaction demand loads. Communications capacity must be sized according to estimates of peak transaction demands on the system. The goal in determining needed capacity is to eliminate or minimize the number of occurrences in which transaction processing cannot be accomplished during peak periods simply because there is no open telephone line to the system.

PROCESSING THROUGHPUT

Processing throughput is a measure of processing capacity. As a computer system either increases the speed with which it processes system functions or increases the number of functions which can be processed at the same time, throughput increases. Therefore, a clear relationship exists between processing capacity and system processing speeds. One performance issue for processing throughput, then, is whether processing capacity is sufficient to support the processing speeds needed to meet the system's response time performance standards.

To ensure adequate processing capacity, total processing demands on the system for all real-time and batch processing functions must be estimated. It is especially important to anticipate total processing demands during peak periods of system usage. These demands will determine the initially needed capacity of the system. Because the number of recipients using an EBT system may expand over time, however, probable future peak-load demands on the system must be considered. The degree to which future growth should affect short-term capacity decisions depends on how soon the growth is expected and how easily processing capacity can be expanded after the initial system is implemented.

When determining how much communications capacity and processing capacity is required for a given system, situations may arise in which it is not cost-effective to provide enough capacity to meet peak demands fully. For instance, if extremely high demand peaks occur very infrequently, sizing the system to handle the extraordinary peaks may be so costly that instances of reaching capacity must be accepted. Given the difficulties that system inaccessibility places on retailers and recipients, however, these instances should be avoided wherever feasible.

FILE SIZE AND ORGANIZATION

An EBT system must create and maintain a number of computer files to support operations. Account files for recipients must be updated as issuances are posted, and files for both retailers and recipients must be updated as transactions are processed. A transaction file must be maintained to support reconciliation and audit trail requirements, and transaction files must be archived to maintain a historical record of all system activity. Finally, a number of intermediate, working files may be needed to support normal system processing requirements. Although these latter files are temporary, they add to the overall file capacity requirements of the system.

System files must be maintained on data storage devices. These devices include magnetic computer tapes, disks, and diskettes. File capacity for files placed on magnetic tape is essentially limitless. However, files placed on magnetic tape take longer to process than files placed on computer disks or diskettes. To maximize processing efficiency, then, system designers try to maintain most active system files on disks or diskettes. File capacity is controlled by the amount of space allocated on these devices for individual files. Thus, available disk space is the constraining factor for determining system file capacity.

The system developer must consider two factors when determining needed disk space: the total number of files to be maintained on disk or diskette data storage devices, and the amount of storage space required for each file. Required storage space for individual files is a function of the amount of information contained in each file record and the number of records placed in the file. Thus, unlike requirements for processing and communications capacity, file capacity requirements are related more to the amount of information to be maintained in each file and to total transaction volumes (which affect the number of records to be placed in transaction files) than to volumes during peak demand periods.

If the system fills all allocated space on a disk or diskette file, normal processing cannot continue until either more space is allocated, some of the information is removed, or the file is reorganized into a more efficient configuration. For a given space allocation, two different factors can cause the system to run out of space. First, records stored in the file may not be efficiently designed; for example, they may contain information which

is not really needed for system operations. Such additional information increases record length, unnecessarily occupying needed space. Second, the system may try to place too many records into the file, given the actual record length and the space allocated.

If actual levels of system activity exceed expected levels, the system may try to place more records into transaction files than can be accommodated with allocated disk space. This makes it important to estimate total transaction loads accurately, so it can be determined how much file space to allocate for transaction files. The number of recipient and retailer account records also may exceed allocated file space as new recipients or retailers

3.2 PRACTICES IN MEETING CAPACITY REQUIREMENTS

System capacity requirements for communications, processing throughput, and file structure and organization must be tailored to each new system application. Although there appear to be no standard "rules of thumb" linking expected levels of system demand to required system capacity, established procedures exist for accomplishing this task. Some examples are described below.

ESTIMATING TOTAL AND PEAK TRANSACTION DEMANDS

As noted in the previous section, communications and processing capacity requirements are directly related to peak transaction levels. File capacity requirements are related to total transaction levels. When determining a systems's needed capacity, therefore, both total and peak expected transaction demands must be estimated.

The first step in estimating expected transaction loads is to estimate total transaction demand for a specified unit of time. Because food stamp benefits are issued on a monthly basis, it is reasonable to begin by estimating total monthly transaction levels.

Monthly transaction demand for an EBT system depends on the number of recipients using the system each month and the average number of EBT purchases each recipient makes per month. For commercial POS systems, the number of people using the system each month is related to the size of the cardholder base. The size of the cardholder base is the number of debit cards issued by financial institutions or retailers participating in the system. For an EBT system, the "cardholder base" is the number of food stamp recipients placed on the system.

Once the size of the cardholder base is known, POS system planners estimate the expected number of cardholders who will use their cards each month. Little information exists on debit card usage for point-of-sale purchases, but experience with automated teller machines (ATMs) is relevant. This experience suggests that, on average, less than one-half of all cardholders currently use ATMs in a given month. The EBT pattern is much different because food stamp recipients in EBT systems must use their cards to access food stamp benefits. EBT planners can expect usage rates to approxi-

mate 100 percent. In fact, from 102 to 104 percent of all current program participants in Reading made EBT purchases each month. The figure exceeds 100 percent because former recipients continued to use their cards to access benefits that remained after their cases had been formally closed.

After estimating the percentage of all cardholders expected to generate POS activity, the system developer must estimate how often cardholders will use their cards at the point of sale each month. The Reading EBT demonstration provides the only evidence to date of how often food stamp recipients use their benefit cards to purchase groceries. Between February and December of 1985, the average number of EBT purchases per currently active recipient in Reading ranged from 7.1 to 8.9 transactions each month. The mean for the entire period was 8.3 transactions per month.

From expected monthly demand levels, the developer must estimate expected peak demands. Although operators of commercial systems in Iowa and Florida did not provide information relating peak loads to monthly volume, they stated that their peaks tend to occur on Friday afternoons between 5:00 PM and 6:00 PM.

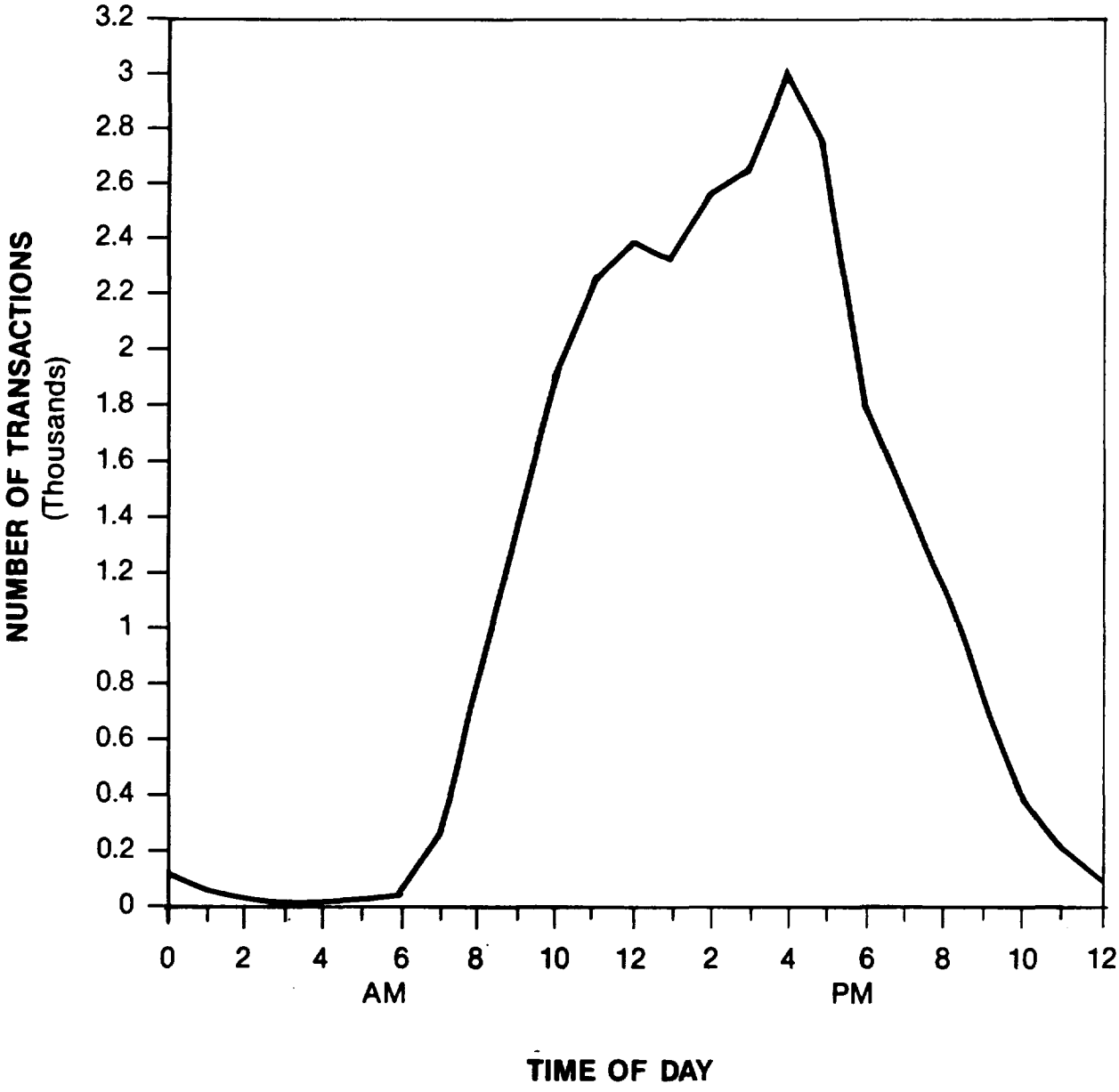
Hourly peak loads for the EBT system in Reading occurred between 3:00 PM and 6:00 PM, as shown in Exhibit 3-1. Retailers report that this is the same peak shopping period for their non-food stamp customers. The coincidence in peak shopping hours was somewhat unexpected. The system's developer had expected food stamp households' shopping trips to be distributed more evenly throughout the day.

The number of hourly purchases shown in Exhibit 3-1 does not reflect peak hourly transaction demand on the Reading EBT system. Exhibit 3-1 reflects the total hourly demand across all days in a month. As discussed below, daily system usage in Reading varied considerably within each month of the demonstration. Thus, the maximum hourly demand on the system exceeded the peak shown in Exhibit 3-1. The maximum hourly demand is needed to estimate system capacity requirements.

Until July 1985, all food stamp recipients in the Reading demonstration received their benefits on the same day of the month. The solid line in Exhibit 3-2 shows how daily transaction volumes varied from one issuance day

Exhibit 3-1

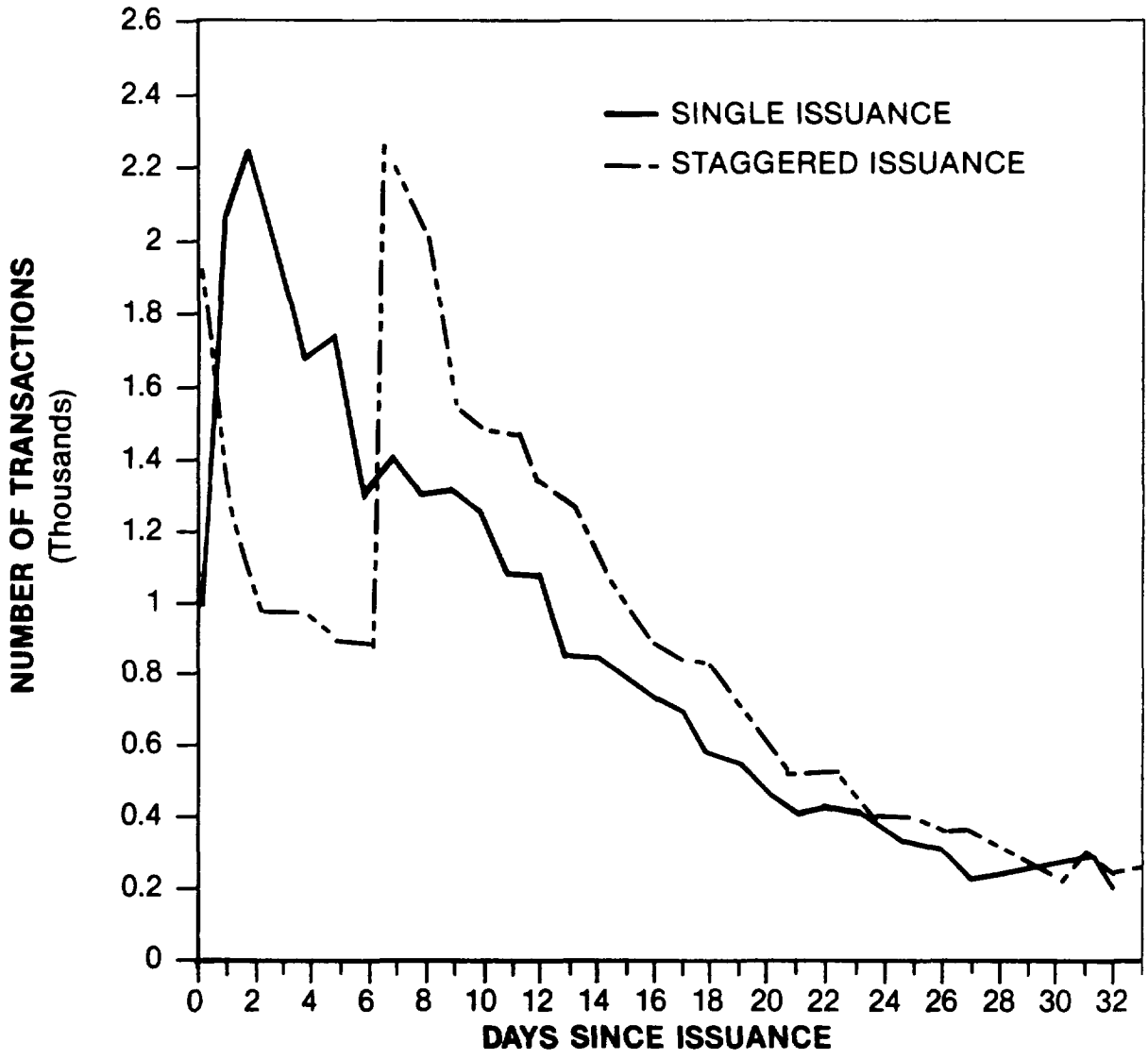
AVERAGE MONTHLY EBT PURCHASE VOLUMES,
BY TIME OF DAY



Source: Archived history files of the Reading EBT system.

Exhibit 3-2

AVERAGE DAILY EBT PURCHASE VOLUMES, BY DAYS SINCE ISSUANCE



Note: Actual issuance date (for single issuance months) and first issuance date (for staggered issuance months) correspond to 0 days since issuance in the exhibit. During staggered issuance months, the second issuance date occurs seven days after the first issuance date.

Source: Archived history files of the Reading EBT system.

to the next.[1] After a rapid build-up, peak daily usage occurred on the second day after issuance. Thereafter, daily usage dropped rapidly. During the months from February through June, the maximum number of transactions in a single hour (not shown in Exhibit 3-2) ranged from 0.86 percent to 1.31 percent of total monthly transactions. For the five months, the average peak-hour demand was 1.06 percent of total monthly volume.

In an effort to reduce peak hourly volumes on the system, the state implemented a staggered issuance schedule. Beginning in July, approximately one-half of all food stamp households in Reading received their regular monthly benefits on the fourth workday of the month. The remaining food stamp households received their regular monthly benefits one week later.

The dotted line in Exhibit 3-2 shows the impact of staggered issuance on daily transaction levels. The effect was unexpected. Instead of reducing peak daily loads, staggered issuance merely shifted the peak to a later date. As expected, however, staggered issuance did have some effect on peak hourly volumes. From July through December, peak hourly transaction demand ranged from 0.85 percent to 1.03 percent of total monthly transaction volumes. For the six months, the average peak-hour demand was 0.93 percent of total monthly volume, down about 12 percent from the average peak-hour demand of 1.06 percent for February through June.

Two reasons appear to explain why staggered issuance did not reduce daily peak loads on the Reading system. First, the average monthly transaction volume increased by 3.7 percent between the two periods. Second, recipients had better information as to when monthly benefits were posted to their accounts after staggered issuance was implemented. Prior to July, benefits were supposed to be posted to accounts on the fourth workday of each month. However, FNS authorized PRC to post benefits earlier to allow some flexibility in scheduling the Update program, which required from four to five hours to run. Some recipients who checked their account balances before the fourth workday found that their benefits were accessible, and began shopping

[1]Given the monthly schedule of issuance dates, there were months in which up to 33 days passed between one issuance date and the next.

immediately. But not all recipients realized that their benefits had been posted. The effect of this uncertainty was to spread the peak transaction volume over several days. This effect can be seen in Exhibit 3-2 in the rapid escalation of daily transaction volumes over the first two days of the issuance month. (PRC's actual posting date defines the start of the issuance month in Exhibit 3-2.) In contrast, from July through December, the initial peak occurs exactly on the day of issuance -- the fourth workday of the month.

For State Agencies planning future EBT systems, it is desirable to have an estimate of the effects of staggered issuance on peak-hour transaction levels that avoids the confounding issues described above. Using daily transaction totals from March 1985 (the only single-issuance month in which benefits were posted to recipients' accounts on the fourth workday of the month), we simulated the impact of staggered issuance on daily transaction levels.[1] The actual peak daily level was 2,638 transactions, on March 6, issuance day.[2] The simulation indicates that, if one-half of the demonstration households had received their March benefits one week later on March 13, the peak daily transaction level would have been 2,018 transactions (on March 13), a 24-percent decrease from 2,638 transactions. If issuance for the second portion of the caseload had been delayed by two weeks instead of one week, the peak daily transaction level would have been 1,633 transactions (on March 20), a 38-percent decrease. The simulation therefore indicates that peak daily transaction levels in an EBT system can be reduced with staggered issuance dates. Because peak hourly demands should occur on days of peak daily demand, staggered issuance can reduce system capacity requirements.

After estimating peak hourly demands on the system, the planner must translate these demands into the maximum expected number of transactions that the system must process simultaneously. There appears to be no standard method for this conversion. In designing the Reading EBT system, PRC used a Poisson distribution to statistically allocate total hourly demand throughout the hour.

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[1]The simulation is described in Appendix A.

[2]System problems on March 6 probably prevented some EBT purchases being made that day. This should not have a major impact on the simulation.

ESTIMATING NEEDED COMMUNICATIONS CAPACITY

Communications capacity requirements follow from the analysis of peak transaction loads. With the number of peak transactions estimated, the number of telephone lines required to handle these peak loads can be ascertained using queueing theory. The only additional information needed to perform the analysis is the total length of time a telephone line will be occupied while a purchase transaction is being processed. Because this length of time is related directly to system processing speeds, required communications capacity depends upon both peak transaction loads and the system's processing throughput.

ESTIMATING NEEDED PROCESSING CAPACITY

Both real-time and batch processing functions place demands on system processing capacity. Although batch processing demands cannot be ignored, real-time functions have peak levels that tend to define maximum processing demand. Thus, estimating peak transaction volumes in an EBT system is a key element in estimating processing capacity requirements. Once peak transaction volumes and their processing capacity requirements are estimated, additional batch processing demands during the system's peak transaction periods may be added to determine total peak processing demands.

Commercial POS system operators suggest that peak transaction processing should utilize only 40 to 60 percent of system processing capacity. Data processing personnel at FNS indicate that peak transaction processing should utilize only 50 percent of total processing capacity. These rules of thumb allow for possible estimating errors and for concurrent processing demands from other system functions. Thus, for initial planning, processing capacity should be about twice expected peak transaction usage. As transaction demand grows over time, POS operators recommend upgrading the system's processing capacity by the time that peak demand reaches 80 percent of processing capacity.

ESTIMATING NEEDED FILE CAPACITY

Determining required file capacity is a separate exercise. After deciding what files will be required to operate the system and what information they will contain, the developer must estimate how many records each file will need to hold. This depends on the number of system participants and the overall level of expected system activity, factors which will have already been estimated for the analysis of peak transaction demands.

3.3 PROBLEMS ENCOUNTERED IN THE READING EBT SYSTEM

The Reading EBT system experienced problems in all three areas related to system capacity: communications, processing throughput, and file structure and organization. Problems with processing capacity and actions taken to reduce these problems were discussed in Chapter Two. This present section focuses on the problems encountered with limited communications facilities and file capacity, the major reasons why these problems developed, and the actions that PRC took to ameliorate the problems.

COMMUNICATIONS CAPACITY

The Reading EBT system encountered two sets of problems related to limited communications capacity. Minor problems arose from the number of telephone lines installed in retail stores. The main problems concerned the number of telephone lines which connected to the system's computers at the EBT Center.

Most Benefit Transaction Terminals (BTTs), located at checkout counters in retail stores, shared telephone lines with other store terminals or with the store's regular business line. Some terminal transmissions to the EBT Center could not be initiated simply because the line was already in use. These problems were infrequent enough, however, that corrective actions (e.g., adding more lines at the store) were not deemed necessary.

Lack of available open lines to the EBT system's computers caused most of the communication problems in Reading. At the start of the demonstration there were six lines to the system's computers. Although the system

could process only one transaction at a time, store terminals could dial up the system and wait for transaction processing unless all six lines were in use. The EBT Center maintained a log throughout the demonstration of line usage for these six lines. Exhibit 3-3 shows the monthly count of occasions when all six lines were in use and the total time they were in use.

The full initial demonstration caseload of 3,632 recipients did not begin using the system until January 1985. The figures in Exhibit 3-3, however, reveal that capacity problems with the system's six lines began as early as November 1984, when only about 72 percent of the initial caseload was making EBT purchases. The capacity problems peaked in February when all six lines were in use at the same time for a total of more than 3.5 hours.

Further investigation of the line usage data indicates that approximately 44 percent of the capacity problems occurred between 4:00 PM and 7:00 PM, which closely matches the period of peak transaction volumes for EBT purchases (Exhibit 3-1).

PRC responded to the system's line capacity problems by adding a seventh telephone line to the system's computers on March 22, 1985. Unfortunately, due to expense considerations, the equipment used to monitor line usage (a Dacon Call Sequencer) was not modified to include the seventh line. Thus, no line usage data are available which indicate how often all seven lines were in use after March 22.

It should be noted that, even for the October 1984 to March 1985 period, the data in Exhibit 3-3 are only suggestive of the number of times retailers could not access the system because an open line was not available. If no other calls were attempted when all six lines were busy, no access problems would occur. To gain a better measure of the access problem, Bell Telephone of Pennsylvania conducted two studies for PRC to determine how often store terminals encountered busy signals when attempting to transmit a transaction message. The first study covered the four-week period from March 11 through April 5. The second study covered the five-week period from April 22 through May 24. Both studies were conducted only during weekdays.

Even though the first Bell study provides some information relevant to the incidence of busy signals before and after the addition of the seventh

Exhibit 3-3

FREQUENCY AND TOTAL DURATION OF ALL SIX COMPUTER LINES IN USE

Month	Frequency	Total Duration (minutes)
1984		
October	18	3.0
November	596	110.3
December	458	82.5
1985		
January	503	53.0
February	1,350	217.8
March	270	45.0
April	---	----
May	424	64.3
June	---	----
July	437	49.6
August	381	54.9
September	90	9.6
October	325	19.2
November	140	18.4
December	74	11.1

Note: Reliable line usage data for April and June are not available.

Source: Dacon Call Sequencer reports provided by the EBT Center.

telephone line, the two studies really do not provide enough data to determine the impact of the seventh line on communication access problems. The second study covers the period when May benefits were issued, whereas the first study begins five days after the March issuance. Thus, the periods before and after March 22 covered by the Bell studies are not comparable in terms of transaction volumes.

Despite the peak transaction loads encountered during the second study, access problems did seem to be reduced after installation of the seventh line. During the nine study days preceding March 22, the probability of a store terminal encountering a busy signal when attempting to dial up the EBT Center was 0.01. After March 22, the probability was 0.005 on those days covered by the two Bell studies.[1] On May 6 (issuance day), however, the probability of a busy signal was very high (0.04) despite the addition of the seventh line. The EBT system processed 2,909 purchase transactions on May 6, the heaviest daily transaction volume of the entire demonstration.

The apparent reduction in telephone access problems after March 22 cannot be attributed solely to the addition of a seventh telephone line. As discussed in Chapter Two, PRC modified the system's software and increased time-out periods in selected store terminals during March. These modifications reduced processing requirements and increased system processing speeds. Thus, some improvement in access to the system would have occurred even without the addition of the seventh telephone line.

The access problems encountered through March can be partly attributed to two assumptions underlying estimates of the number of lines required to handle peak transaction loads. First, PRC underestimated peak hourly transaction volumes by about 30 percent. Actual average peak hourly volume between November 1984 and March 1985 was 237 transactions (1.05 percent of an actual average monthly volume of 22,253 transactions), compared to PRC's peak estimate of 167 transactions per hour (0.84 percent of an estimated total

[1]The probability estimate of 0.005 excludes transactions and busy signals on May 24, the last day of the second Bell study. The EBT Center used only the backup computer on May 24, and the backup computer supports only four incoming telephone lines. The probability of a busy signal on May 24 was 0.07.

monthly volume of 20,000 transactions). Second, PRC assumed that each transaction would occupy a telephone line for about 15 seconds. As a result of the slow processing speeds discussed in Chapter Two, the actual time a transaction occupied a line averaged about 26 seconds. This estimate includes time to transmit messages to and from the computer, time waiting in the processing queue, processing time, and receipt printing time. It excludes PIN verification time at the terminal and dial-up time.

FILE CAPACITY

The Reading EBT system experienced several problems related to the size and organization of system files. Software difficulties caused some of these problems (see Chapter Four). Problems related to file capacity are discussed here.

Problems with the Size of the History File. One potential file capacity problem during the Reading demonstration was the size of the system's History File. Although the capacity of the file was never reached during the demonstration, there were months in which the file neared full utilization. System processing would have been interrupted if the file had ever reached capacity.

The History File documents many different system activities. All system activities that change information in the system's Master File are documented, including purchase and refund transactions, benefit issuances, manual purchase authorizations and their subsequent reconciliation, and changes in the status of a recipient's account. Other activities which are documented include encoding of recipients' and retailers' EBT cards, balance queries, invalid-PIN entries (after three consecutive unsuccessful attempts to enter a PIN), and instances of attempted purchases which exceed a recipient's remaining balance. Each of the above activities generates at least one record to be added to the History File. Some of the activities generate more than one record (for instance, four records are generated whenever an EBT card is encoded).

The History File is divided into three equally sized subfiles, each corresponding to one month's worth of documented activities. At the end of

every month of operations, the oldest subfile is copied onto tape to provide an archived record of all system activities. The space allocated for this subfile is then used for recording the next month's activities. Thus, the History File always maintains between two and three months of information on system activities.

The History File is maintained on a disk storage device. Each subfile is allocated enough space to hold 40,000 records. In determining needed file space during the system's design phase, PRC estimated that the system would process about 20,000 purchase transactions each month, and each purchase transaction requires that one record be written to the file. The remaining capacity of 20,000 records would be used to document all non-purchase activities.

In February 1985, PRC noted that the system used over 86 percent of January's History File space to record system activities. There were 24,056 purchase transactions during January. During February, when the system processed 27,487 purchase transactions, nearly 79 percent of the History File was utilized. The utilization rate dropped in February largely because card encoding activities decreased substantially after the last major wave of recipients was added to the system in January.

PRC has not noted any concerns with the capacity of the History File since February. The high utilization of the file in January, however, serves as a reminder of a system's potential for file capacity problems. The basic cause of the high utilization rate was an underestimation of the monthly volume of purchase transactions in the Reading EBT system. Whereas PRC planned for 20,000 purchase transactions each month (by assuming a caseload of 4,000 recipients and an average of five purchase transactions per month for each recipient), actual purchase transaction volumes averaged 28,420 transactions per month between February and December. Contributing strongly to January's high utilization rate were the 1,140 EBT cards encoded that month (each adding four records to the file); this points out the need for accurately estimating the incidence of all activities which place demands on system file use.

Two other problems related to the History File occurred during the demonstration. The June subfile appeared to reach capacity early in the month. When PRC investigated this problem, they discovered that June's history records were not being rewritten over old March records. Instead, June activities were being recorded in unused space left over on the March subfile. This problem was attributed to operator error. Although quickly resolved, the problem did delay system processing.

The remaining problem related to the History File arose from PRC's misunderstanding of FNS desires for an on-line capability to access History File records. FNS desired that 60 day's worth of system activity be retrievable at any time to investigate recent system activity. Instead, PRC designed the system so that only the current month's and the past month's records could be accessed. Thus, depending on when during a month the file was accessed, between 30 and 60 days' history records could be retrieved.

Apart from the apparent capacity problem in June which was quickly resolved, PRC did not make any changes during the demonstration to increase either the capacity of the History File or the on-line capability of accessing History File records. PRC staff said that providing greater on-line capability would have been relatively simple during system design, but that expanding the capability after system implementation would have been time consuming and possibly disruptive to system operations. With regard to expanding file capacity, the addition of the 200 megabyte cache disk in June provided sufficient space for an expanded History File. However, all program code for writing records to the History File is based on a subfile size of 40,000 records. Changing the program code is a relatively simple, but tedious, exercise. PRC decided that the probability of actually exceeding the capacity of the History File was low enough that incurring costs to increase file size was not justified.

Problems with the Total Number and Size of Files. The total number and size of system files for the EBT system created some disk capacity problems until the 200 megabyte disk was added in June. The original system configuration provided 94 megabytes of disk storage -- 64 megabytes on the primary computer's disk and 30 megabytes on the secondary computer's disk. Each disk held the system's data files (e.g., the History File and the Master

File) and all program and application code needed to run the system. Only about two megabytes of unallocated space was left on each disk.

The lack of more unallocated disk space posed several problems for system operations. For instance, the History File could not be expanded and substantial expansion of the Master File could not be accommodated. Furthermore, EBT Center operators had to copy program files from the disks to tape each day and reallocate disk space in order to provide space for temporary work files. After the addition of the 200 megabyte cache disk, files no longer had to be copied to tape and then recopied back to disk to provide temporary space for work files.

As noted, limited space for Master File expansion caused PRC some concern. As the demonstration progressed, new program participants in the demonstration area were added to the system. Although account records for the new participants were added to the Master File, account records of previous participants were never deleted. A similar situation existed for the account records of participating retailers, although at a much smaller scale. By the end of the demonstration, the number of account records in the Master File had grown from approximately 4,100 to about 6,250.

In an on-going EBT system, maintaining inactive accounts on a Master File will eventually lead to an unnecessarily large file which could create capacity problems.[1] As discussed earlier in this chapter, a State Agency should develop criteria consistent with program regulations for deciding when inactive accounts can be deleted from system files. For the extension of the Reading EBT demonstration, the Pennsylvania Department of Public Welfare plans to initiate the following procedures for deleting account records if file capacity problems are encountered:

- Delete those accounts for which an EBT card was never encoded (i.e., the recipient never attended a training session). If the recipient re-establishes program eligibility, one month's worth of benefits will be reissued.

[1] A larger Master File also increases processing time for any system functions which need to read the Master File or access a record from the file.

- Delete those accounts for closed cases with no benefits remaining in their EBT accounts.

- For currently eligible households with active accounts with a remaining balance, close the case and delete the account (after appropriate notice) if benefits have not been used for 90 days. If the recipient re-establishes program eligibility, the previous remaining amount of benefits will be reissued.

The State will implement procedures for tracking which accounts are deleted and the amount of benefits subject to possible later reissuance.

3.4 RECOMMENDATIONS WHICH SHOULD IMPROVE CAPACITY PERFORMANCE

The likelihood of problems occurring with either communications, processing throughput, or file capacity should be reduced if the following recommendations are followed during system design and implementation.

1) Estimate expected transaction volumes and size the system accordingly.

Monthly transaction volumes affect needed file capacity. Transaction volumes during peak hours of system use affect system processing speeds and determine needed processing and communications capacity. This recommendation therefore repeats the second recommendation presented in Section 2.5. The importance of accurately estimating expected transaction volumes cannot be understated. Inaccurate estimates can impair system performance in several

The Reading activity levels provided earlier (Exhibits 3-1 and 3-2) can aid future developers of EBT systems when they estimate expected transaction volumes. It should be noted, however, that the shopping patterns of Reading food stamp recipients may differ from shopping patterns in other locales. Many factors could conceivably affect local shopping patterns, including the number, size and diversity of available food markets, the demographic characteristics of the recipient population, and the schedule for issuing food stamp benefits. The number and type of available food markets may be a particularly important -- and uncontrollable -- factor affecting the number of separate shopping trips (and, hence, EBT purchases) recipients make to purchase their groceries. For instance, Reading has many small specialty food stores, including a farmer's market with numerous separate stands, which may have increased the average number of monthly EBT purchases during the demonstration. In addition, Reading's relatively small geographic area and the availability of numerous food stores may have reduced the need to concentrate shopping into a few major shopping trips.

Because local shopping patterns may diverge from the patterns observed in Reading, developers of future EBT systems should try to ascertain actual shopping patterns before designing the system. Local retailers may be able to provide estimates of how often food stamp recipients use coupons to pay for groceries in their stores. A sample of current food stamp recipients could be asked to keep records of how often (and when) they shop during the month. (Experience in Reading suggests that recipients underestimate their number of monthly shopping trips when asked after the trips have been made.) Such activities should help developers tailor their estimates of system use to local conditions.

After estimating total and peak-hour transaction volumes, the system developer should probably increase these estimates somewhat to ensure that the system's capacity will not be strained if actual usage exceeds expected usage. The amount of the increase should reflect the anticipated loss in performance if the estimates are incorrect. The greater the damage from unexpected high usage levels, the greater should be the safety factor. Given the experience in Reading, a system developer might plan for a monthly average of ten transactions per recipient unless solid evidence suggests otherwise.

Of course, as future EBT systems are implemented, their usage patterns can aid estimates for later systems. In addition, further analysis of EBT system usage in Reading is planned. By the middle of 1987, shopping patterns for different demographic groups in Reading will be documented. This information may help in estimating expected usage patterns for recipient populations with a different mixture of demographic characteristics than Reading recipients.

2) Consider the impact of all required system functions on capacity requirements.

Transaction processing is not the only system function affecting needed communications, processing and file capacity. Other real-time functions include card encoding, balance queries, and logging of insufficient-balance and invalid-PIN messages. Batch processing functions also require access to system resources. The system developer, therefore, should consider the demands of all system functions when determining needed capacity requirements. Because communication and processing requirements for transaction processing will be greatest during peak-volume periods of system use, particular attention should be given to additional system demands from other system functions during these peak periods.

3) Design the system to facilitate expansion of communications, processing and file capacity.

Future capacity requirements are more difficult to estimate than current requirements. The food stamp caseload in the area served by an EBT system might grow, thereby increasing system usage. More retailers might open for business. The State Agency might wish to expand the area served by the system. Therefore, insofar as possible, an EBT system should incorporate features which make it easy to expand communications, processing and file capacity.

To facilitate expansion, the basic system design should enable a switch to a faster computer without redesign of the entire system. The system's computers should be able to handle more incoming telephone lines than originally planned. They also should support the addition of more or larger disk storage devices. Finally, the above changes in system hardware should

not require a complete rewrite of the system's software. The original software should be flexible enough that relatively minor changes in program code will allow the developer to change hardware without disrupting system processing.

4) Monitor actual usage levels to identify potential capacity problems.

The operator of an EBT system should monitor activity levels after system implementation to determine whether or not actual usage levels exceed expected levels. If monitoring suggests that potential capacity problems loom, steps should be taken immediately to increase system capacity or, if feasible, to reduce peak loads on the system.

Higher-than-expected usage levels can affect several different elements of an EBT system, so each element should be monitored. Communications line usage should be monitored to ensure that access problems do not arise during peak transaction periods. The system should report total transaction loads for a month (which affect file size requirements) and for peak hours (which affect communications and processing capacity); the system operator should review these reports immediately after implementation and periodically thereafter. The ongoing review of system usage is necessary because usage levels may change over time.

An EBT system may not reach peak usage for several months after system implementation. Food stamp recipients must be trained before they begin using the system, and training large numbers of recipients may require substantial time. The system developer can monitor system use during any phase-in period to determine if capacity problems are likely to occur after all recipients are using the system. This early monitoring will provide extra time to remedy potential capacity problems before they occur. In Reading, for example, PRC noted problems with system processing capacity when only about 72 percent of the entire demonstration caseload had begun using the system. PRC engineers immediately began identifying the cause of the processing problems and developing alternative solutions. To avoid greater problems with system capacity, the Pennsylvania Department of Public Welfare put off training the

remaining portion of the caseload by one month to give PRC more time to implement system improvements.

Chapter Four

SYSTEM RELIABILITY

Chapter Four

SYSTEM RELIABILITY

An EBT system should be available to handle purchase transactions whenever food stamp recipients can buy groceries with cash, unless food stamp authorities decide to limit normal system operating hours. The system should process all transactions accurately. Because problems with either system availability or system accuracy can impose great hardship on recipients and retailers, an EBT system must maintain a very high degree of reliability.

4.1 GENERAL PERFORMANCE ISSUES

The basic objective of an EBT system is to process purchase transactions electronically, eliminating the use of food stamp coupons. A number of system elements must work properly to meet this objective. The system must be able to transmit purchase information from the point of sale to the system's computer facilities (assuming an on-line system design). The computer facilities must be available to process the information when purchases are attempted. The system's software must process the purchase transaction information correctly.

AN EBT SYSTEM MUST BE ABLE TO TRANSMIT PURCHASE INFORMATION

To initiate an EBT purchase transaction, a food stamp recipient must pass the EBT card through a card reader at the point of sale. Assuming the system requires a PIN to verify the recipient's identity, the recipient must enter the PIN on a PIN-pad. An EBT terminal at the checkout counter must then format a valid transaction message, access a communications line, and -- once the computer facility is ready to accept the transaction message -- transmit the message to the system. To complete the purchase, a receipt for the EBT transaction must be printed for the recipient.

If the recipient's card or any piece of the store's equipment (i.e., card reader, PIN-pad, terminal, modem, and printer) is not functioning proper-

ly, the recipient's benefits cannot be accessed electronically. Thus, both the EBT card and the store's equipment must work reliably.

AN EBT SYSTEM'S COMPUTER FACILITIES MUST BE ABLE TO PROCESS TRANSACTION INFORMATION

EBT system failure imposes potentially greater hardship on the recipient than failure of a store's EBT equipment. If a piece of store equipment does not work, the recipient may be able to use equipment at another checkout counter in the store. If there is no other EBT equipment in the store, the recipient could go to another store to purchase groceries. In contrast, if the system cannot accept and process EBT transactions, the recipient must wait until the system is again functioning in order to buy groceries electronically.

It is important to define system reliability in terms of the system's ability to accept and process purchase transactions. An EBT system's hardware or software does not have to fail completely to prevent the system from accepting and processing transactions. If the computers are too busy performing other functions to process transactions, the system is just as inaccessible to recipients and retailers as if it completely fails. Similarly, if the system's computers are operating and ready to process transactions, but some other hardware or software failure keeps the transaction from being processed, the system is inaccessible. Thus, traditional computer system measurements of system "downtime" do not necessarily indicate the system's overall level of reliability.

To achieve a high degree of system reliability, backup equipment or some alternative form of redundant capacity may be needed to continue processing when a partial failure occurs. Providing backup capability will certainly increase system costs, but the potential adverse effects of system inaccessibility warrant such measures. The system should be designed to minimize delays in switching to backup equipment in the event of equipment failure.

MANUAL AUTHORIZATION PROCEDURES SHOULD BE AVAILABLE

Regardless of how well an EBT system is designed and operated, there may be instances when the system completely fails. A manual procedure for

authorizing EBT procedures must therefore be an integral part of the design of an EBT system. The manual procedure should be designed to avoid authorizing purchases when the recipient's remaining benefits cannot cover the intended purchase. If the manual design cannot rule out potential overdrafts, a dollar limit for manually authorized purchases may be needed.

AN EBT SYSTEM MUST PROCESS TRANSACTIONS ACCURATELY

Accurate processing of all purchase and refund transactions and other system functions is critical to the successful implementation of an EBT system. If purchase and refund transactions are not processed accurately, recipients may receive incorrect "insufficient balance" messages when they attempt EBT purchases. This situation is not only embarrassing, it prevents recipients from using their authorized food stamp benefits. If the system incorrectly indicates more benefits in a recipient's account than should be available (through either inaccurate processing of previous transactions or incorrect posting of issued benefits), the recipient may use these benefits before the error is discovered, a potential monetary loss for the Food Stamp Program.

Inaccurate processing of purchase and refund transactions affects retailers as well, as retailers' bank accounts will be credited either too much or too little. If the error is never discovered, either the retailer or the Food Stamp Program will suffer a monetary loss. Store managers and the system operator will incur additional administrative costs discovering and correcting errors caused by inaccurate system processing.

Occasional processing errors impose hardship on the affected individuals, but frequent errors cause more general problems. Retailers' and recipients' confidence in the system may erode. Even if the processing problems are corrected and the system becomes reliable, regaining participants' confidence in the system may be slow and difficult.

Given these difficulties and costs, the system developer should take great care prior to system implementation to ensure that the system's software supports accurate processing of all system functions. The system developer also must recognize, however, that the potential for error always exists. Therefore, procedures for discovering and correcting errors, including mechan-

isms for recovering excess funds which are inadvertantly credited to retailers' or recipients' accounts, should be established prior to system implementation.

4.2 PERFORMANCE STANDARDS FOR SYSTEM RELIABILITY

Performance issues surrounding system reliability cover several different system elements: EBT cards and store equipment, the system's accessibility to retailers and recipients, manual authorization procedures, and accurate processing of system functions. Performance standards can be specified for each element.

EBT CARDS AND STORE EQUIPMENT

EBT cards are perhaps the single system element most vulnerable to performance failure. At the present state of POS technology, debit cards are typically plastic cards with a magnetic stripe embedded on the back. Information about the card holder is encoded on the magnetic stripe, and this information must be read from the card before a transaction takes place.

Although magnetic stripe debit cards are technically simple devices, they are vulnerable to excessive use or misuse. If the plastic card cracks or if the unprotected magnetic stripe is scratched, the card may no longer be readable. In choosing card stock for an EBT system, therefore, the system developer should select a card which has been reliable in other POS environments. Current bank debit cards are typically issued for two-year periods. Although this two-year period is imposed, in part, for security reasons, it also reflects experience with the durability and reliability of existing debit cards.

To improve card reliability, cardholders can be instructed in taking reasonable care of the cards. Recipients in Reading received a special plastic wallet to hold their cards. The wallet helps protect the card and its magnetic stripe when the card is not in use.

EBT equipment at checkout counters also must be reliable. Stores' EBT equipment includes a terminal, a modem, a card reader, a PIN-pad, and any printer used to print receipts for EBT transactions. Depending upon the

equipment selected, these separate elements may be integrated into single pieces of equipment. In the Reading system, for instance, the terminals and the card reader are integrated. In other systems the printer may be integrated with the terminal, or the card readers with the PIN-pad.

Some POS systems have explicit performance standards for store equipment. The Florida POS network, for example, has a performance standard of 98 percent -- that is, store equipment must operate properly 98 percent of the time the store is open for business.

A number of manufacturers now provide equipment for POS systems. Vendors generally have reliability figures for their products, and these figures can be verified through communication with operators of systems using the equipment. Contracts to purchase or lease equipment can stipulate expected reliability standards. If these standards are not met, the vendor or the system developer is responsible for replacing the equipment. Even a small EBT system needs a large amount of store equipment, and a State Agency should avoid being put in a position of having to pay for large-scale replacement of unreliable store equipment.

A service contract is normally needed to ensure the continued proper functioning of store equipment. The contract can stipulate maximum response times for repair or replacement of faulty equipment. Next-day service is probably insufficient for EBT equipment maintenance because stores may lose substantial sales when equipment is not in operation. During the Reading demonstration, PRC used its own technicians to service EBT equipment in stores. The technicians were on call 24 hours each day, and were usually dispatched to a store within 20 minutes of receiving notice of a problem. In taking over the Reading EBT system, the Pennsylvania Department of Public Welfare negotiated a service contract with Sperry Corporation. The contract calls for a maximum response time of two hours to repair or replace faulty store equipment. Service calls, however, are not required between the hours of 8:00 PM and 9:00 AM.

SYSTEM ACCESSIBILITY

It is not unreasonable to set a goal of 100 percent accessibility for an EBT system, at least during normal business hours for the majority of participating retail stores. If the system must be inaccessible to retailers

and recipients during periods of normal system maintenance, these periods should take place during hours when very few EBT transaction normally occur. Recipients and retailers should be informed of routinely scheduled system inaccessibility.

Performance standards for actual levels of system reliability should be very close to 100 percent. References to system accessibility in industry trade journals and newsletters often mention 99.5 percent as a minimum figure for system uptime. This figure seems reasonable. For example, a 99.0 percent reliability figure over a thirty-day period translates into 432 minutes of system inaccessibility. Even short periods of inaccessibility at peak-volume hours can create severe disruptions at checkout counters, so 99.0 percent reliability will be inadequate if the periods of inaccessibility concentrate during busy shopping periods. To avoid problems with downtime during busy periods, performance standards for system accessibility probably should be set by time of day and day of month. That is, if a 99.5 percent performance standard is specified, the system should meet this standard not only for the month as a whole, but during peak afternoon shopping hours as well. A 99.5 percent performance standard for the three days after issuance translates into 21.6 minutes of system inaccessibility during those three days. The same standard applied to the 3:00 PM to 6:00 PM time period for Monday through Saturday of each week translates into 5.4 minutes of system inaccessibility during these hours.

The rationale for specifying system reliability standards for selected time periods is that system inaccesibility should disrupt as few EBT transactions as possible. An alternative approach is to specify performance levels directly in terms of the maximum number or percentage of attempted transactions which cannot be completed due to system inaccessibility. This standard could be implemented using data on the distribution of all EBT transactions over all hours of a month (data which the system operator will normally maintain) to estimate the number of transactions that would have occurred during any period of inaccessibility.[1] System records of the hourly distri-

[1]Appendix B presents the percentage hourly distribution of EBT transactions in Reading for selected 30-day months before and after Pennsylvania adopted a staggered issuance schedule for food stamp recipients in Berks County.

bution of accepted transactions, of course, may understate somewhat the number of attempted transactions. For instance, some transactions attempted in prior months may not have been completed due to problems with store equipment, busy signals, or periods of system downtime. To alleviate these measurement problems, months with relatively few known problems could be selected to establish a baseline hourly distribution of transactions. Alternatively, an average hourly distribution over several months could be constructed. Unless problems occurred in the same hours over several months, this latter approach would tend to minimize measurement errors.

Actual system reliability in the Florida POS network has been approximately 99.7 percent, excluding one hour of planned downtime every Sunday morning. System reliability in the Iowa POS network was about 99.6 percent before new processing equipment was installed. Since installation of the new equipment, system reliability has been over 99.9 percent. The latter reliability figures refer to system "uptime." It is not known with certainty whether or not the systems were actually accessible to retailers during all periods of system uptime, but they appear to have been. Representatives of the Florida network said that communications problems, rather than computer problems, were primarily responsible for periods of system inaccessibility.

MANUAL AUTHORIZATION PROCEDURES

When an EBT system is inaccessible, manual procedures must be used to authorize EBT purchases. These procedures should meet three basic performance criteria.

First, as previously noted, the procedures should minimize the possibility of overdrawing a food stamp account. To achieve this objective, the party responsible for authorizing such EBT purchases needs ready access to a recent listing of recipients' account balances. In addition, information about manually authorized transactions should be quickly entered into system account files once the system resumes normal functioning.

Second, the manual procedures must be available when needed. If the manual procedure involves a telephone call to obtain verbal authorization for a purchase, someone must always be available at the designated number to grant the authorization.

Third, the manual procedures should be relatively simple to perform. Manual authorization should be needed only rarely, and complex procedures may not be remembered by retailers, recipients, or those responsible for granting authorization. Complex procedures may lead to inaccurate manual processing, which may pass unnoticed until reconciliation if the manual procedures bypass normal system checks on error.

PROCESSING ACCURACY

Errors in transaction processing and processing of other system functions can arise from three sources. The software governing normal system processing may be in error. The system may be incapable of recovering all account and transaction information if the system fails in the middle of processing a transaction. System operators may introduce errors by not following established operating procedures exactly.

The performance standard for system accuracy should be set at or very close to 100 percent. In the Florida POS network, the processing error rate has been about 0.18 percent of all transactions. Most of the errors occurred when transactions which should have been reversed were not. An example would be transactions not fully processed because the POS terminal timed out before receiving an authorization message. Representatives of the Iowa POS network said that they had not heard about any processing errors.

4.3 PROBLEMS ENCOUNTERED IN THE READING EBT SYSTEM

The Reading EBT system experienced at least some reliability problems with each of the system elements mentioned earlier. The primary difficulties centered around system accessibility and store equipment.

SYSTEM ACCESSIBILITY

The EBT system in Reading uses two IBM Series/1 computers to process purchase transactions. The primary computer is a Model 4956; the secondary computer is a Model 4954. Although the secondary computer is smaller than the primary computer and cannot handle all system functions by itself, it provides immediate backup processing capabilities in the event the primary computer fails.

Inability to Switch Processing Automatically between Computers. The first "problem" with system accessibility occurred well before the system was actually implemented. Under the original system design, control of system processing would automatically pass to the secondary computer if the primary computer failed. In June 1984, IBM informed PRC that neither the software envisioned for this transition nor any other software supported by the IBM equipment could totally control an automatic switch to the secondary computer. Instead, if the primary computer failed, an operator would have to press an Initial Program Load (IPL) button on the secondary computer to accomplish the transfer of control.

In practice, having an operator press the IPL button delays the transfer of control by only an additional five to ten seconds. Without an automatic switch, however, the EBT Center had to be staffed around the clock to ensure backup capability at all times. That requirement altered PRC's original plans to staff the EBT Center only 16 hours each day.

Lack of a Fully Redundant Backup Computer. The absence of a fully redundant backup computer also caused some accessibility problems. The system's secondary computer is smaller than its primary computer. It has less internal memory (256 kilobytes versus 512 kilobytes) and less disk space (30 megabytes versus 64 megabytes) than the primary computer. As a consequence, the backup computer cannot handle all system functions by itself. For instance, if batch programs need to be run when the backup computer operates stand-alone, the Voice Input/Output (VIO) unit cannot be used.[1] Similarly, the backup computer can handle only six of the seven telephone lines which receive messages from store terminals. If lines for receiving information from the BCAO or the PDPW are in use, only four lines from store terminals can be connected.

The lack of full redundancy is not necessarily a problem if the EBT Center can switch back to the primary computer within a short period. If the primary computer is down for a protracted time, however, normal system operations cannot be maintained.

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[1]The VIO unit responds to balance queries with a synthesized voice when recipients call the EBT Center.

Slow Processing Speeds. The system's problems with processing speeds (described in Chapter Two) also affected system accessibility. To improve processing speeds, operators at the EBT Center often decoupled the two computers. When the computers were decoupled, the Master File on the secondary computer was not updated continuously with new transaction information. Instead, transaction information was logged to diskette on the primary computer, and the diskette was used periodically to update the Master File on the secondary computer. If the primary computer failed under this configuration, the Master File on the secondary computer first had to be updated before processing could be transferred. This updating could take up to one hour if the diskette was nearly full, although the average time needed for an update was about 30 minutes. These delays were not acceptable to FNS.

The addition of the 200 megabyte disk in June 1985 largely resolved this issue. Substantial delays in transferring processing to the secondary computer occur under this new configuration only if the Master File on the 200 megabyte disk cannot be accessed. If this occurs, the secondary computer's Master File is updated from the primary computer's 64 megabyte disk.

System Downtime. Failure of the primary computer occurred relatively frequently during the Reading demonstration. In many instances, however, system operators either brought the primary computer back on line or transferred processing to the secondary computer without substantial delays.

Exhibit 4-1 shows the duration of reported system downtime for each month of the demonstration, broken out by "daytime" (6:00 AM to 10:00 PM) and "nighttime" (10:00 PM to 6:00 AM) hours. The downtime figures reflect only those periods when neither of the system's two computers were operating. Problems other than computer failure could impair access to the system, so the numbers in the exhibit overstate the system's accessibility to retailers and recipients. Nevertheless, the numbers in Exhibit 4-1 measure one aspect of system reliability.

Based on the downtime figures reported by PRC, the system's computers operated during 99.4 percent of all hours of the demonstration. The uptime percentage was considerably better during the 6:00 AM to 10:00 PM period (99.7 percent) than during the 10:00 PM to 6:00 AM period (99.0 percent). This difference arose because, whenever possible, PRC scheduled system

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Exhibit 4-1

SYSTEM DOWNTIME DURING THE READING EBT DEMONSTRATION

	Daytime (6 AM - 10 PM)		Nighttime (10 PM - 6 AM)		Overall
Month	Hours	% Uptime	Hours	% Uptime	% Uptime
1984					
Oct	2.50	99.5	0.06	100.0	99.7
Nov	9.23	98.1	2.45	99.0	98.4
Dec	2.42	99.5	0.62	99.8	99.6
1985					
Jan	1.33	99.7	1.15	99.5	99.7
Feb	2.75	99.4	5.13	97.7	98.8
Mar	0.35	99.9	2.10	99.2	99.7

maintenance and repairs during late-night and early-morning hours when few purchase transactions needed to be processed.

Additional review of operator logs for four months of the demonstration identified some periods of apparent system downtime not included in PRC's monthly downtime reports. If these periods reflect actual downtime, the monthly downtime figures in Exhibit 4-1 should be increased by an average of approximately 20 percent. This increase would reduce overall system uptime in Reading to a bit less than 99.3 percent.

System downtime in the Reading EBT demonstration resulted from numerous different causes. Software problems led to approximately 35 percent of the reported total downtime, and hardware problems caused another 30 percent. Nearly 20 percent of the total downtime occurred during periods when PRC engineers needed the system for testing and for development of improved system software.

Software Problems. One of the most persistent software problems during the Reading demonstration was conversion error. According to PRC, these errors occurred when a message from a store terminal to the system included non-numeric data. For most of the demonstration, the system crashed whenever non-numeric data were transmitted.[1] The system can recover quickly when conversion errors occur, however, and only about four percent of the total downtime in Exhibit 4-1 is attributable to conversion errors.

Once PRC identified the conversion error problem, technicians from the EBT Center modified all store terminals in January 1985 in an attempt to eliminate the transmittal of non-numeric data. These modifications substantially reduced the incidence of conversion errors, but they did not eliminate the problem. Further tests by PRC and the terminal's manufacturer could not isolate the conditions under which the remaining conversion errors were occurring. In August 1985, however, PRC finally identified the apparent cause of the remaining conversion errors. When a store terminal is signed onto the system either at the beginning of the day or the beginning of a clerk's shift, the store clerk must enter a two-digit identification code. If clerks with codes from 01 to 09 enter only the last digit of their code, subsequent trans-

[1]PRC changed the system software in September 1985 to reject any BTT transaction messages which included non-numeric data.

action messages from the terminal will cause conversion errors if non-numeric data fill the memory space for the first digit of the code. Resolution of this problem required a reminder to all store clerks to always enter the leading zero of their two-digit identification code.

The system's Indexed Access Method (IAM) software for rapidly accessing account records on the Master File also proved to be a major cause of system downtime in Reading. This software, provided by IBM, uses two "indices" and "file pointers" to locate specific file records without searching through the entire file for the records. The primary index is the recipient's case number. The secondary index is the BIC number encoded on the recipient's EBT card.

Purchase transaction messages do not include the recipient's primary index, only the secondary index. Thus, when processing transaction messages, the software instructs the system to check a portion of the Master File where each recipient's primary and secondary indices are listed together in proper sequence. Once the appropriate secondary index is located, the primary index can be read and used to access the recipient's account record. The IAM software, however, allowed (or perhaps caused) the primary and secondary indices to occasionally be out of sequence. Whenever this occurred, transaction processing was interrupted until the index portion of the Master File was reorganized in the proper sequence. This procedure often required several hours to complete.

To counter this software and database problem, PRC implemented an IBM-supplied "patch" which was supposed to keep the index structure of the Master File in proper sequence. The patch, however, caused problems with other system software, and PRC removed it shortly thereafter. The EBT Center then began checking the index portion of the Master File (in August 1985) on a daily basis to see if the indices were in proper sequence. This check was performed early each morning so that, if index problems were observed, there would be time to reorganize the Master File before significant numbers of purchase transactions needed to be processed.

Hardware Problems. Major hardware problems encountered during the demonstration included failure of the system's chronograph, a faulty control panel board and processor board, failure of a tape drive and diskette reader, and failure of the primary computer's attachment card. PRC addressed these

problems by replacing the equipment. When necessary, PRC called IBM service engineers to diagnose the problems and to replace the equipment.

The Reading EBT system also encountered problems with its Voice Input/Output (VIO) unit. The VIO unit responds to balance queries when recipients use a regular telephone (with touch-tone service) to call the EBT Center. After the recipient keys in his or her case number and PIN, the unit responds in a synthesized voice with the recipient's current account balance.

The system's VIO unit often failed to respond to recipients' calls, although the incidence of such occurrences was never monitored. The problems were episodic and could sometimes be temporarily resolved if operators at the EBT Center switched line connections to the VIO unit. PRC engineers never determined the cause of these accessibility problems (which did not affect transaction processing or any other system functions). Indeed, it was never determined whether the VIO unit itself or its software was at fault. The difficulty in identifying the cause of the VIO problems stemmed from the fact that both the unit and its software were developed by IBM. IBM has discontinued service for VIO units, so PRC could not obtain any support for diagnosing problems in an element of the system which they did not develop.

Operator Problems. Nearly ten percent of the total downtime experienced by the system can be directly traced to errors on the part of system operators. Most of these errors occurred early in the demonstration period when system operators -- hired in the month preceding system implementation -- were still becoming familiar with the system and its operating procedures. Examples of errors include improper handling of computer tapes (including forgetting to initialize a tape prior to its use), not knowing how to transfer processing control from the secondary computer back to the primary computer, inadvertently writing over existing files, failing to reset parameters so that the History File would correctly begin rewriting over old file records, and improper sequencing of system operations.

STORE EQUIPMENT

The Reading EBT system uses Omron CAT-100 terminals and NCR miniprinters at store checkout counters. Because the two pieces of equipment have different manufacturers, PRC technicians fabricated special cables to connect the terminals and printers.

PRC instructed store clerks to call the EBT Center whenever any problems occurred with store equipment or with purchase or refund transactions. When possible, system operators tried to resolve problems over the telephone. Otherwise, operators dispatched technicians to the store to correct the problem.

System operators recorded problems that were reported over the telephone on special log sheets. Based on a review of the log sheets through December 1985, it is apparent that stores did have some problems with the reliability of the EBT equipment installed at checkout counters. As shown in Exhibit 4-2, 595 equipment-related problems were reported during the 15 months of the demonstration (about 40 problems per month). Nearly half of the reported problems related to the NCR miniprinters. The remaining problems involved, in descending order of incidence, the Omron terminals, the cable connections between the terminals and the printers, the phone modems, and the PIN-pads.

A small number of the reported problems can be attributed to simple abuse of the equipment (for instance, soft drinks spilled on the PIN-pads). A larger number of problems appear to have been related to improper use of the equipment. Examples include failure to insert printer paper or printer ribbons properly and printers failing to print a receipt because the store clerk followed the wrong sequence of operations during a purchase transaction.

Most reported problems, however, were true instances of equipment malfunction. These problems always required dispatching a technician to the store. (Some of the other problems mentioned above also required on-site servicing.) In about 71 percent of the service calls, technicians were able to repair the equipment or otherwise correct the problem (e.g., by correctly installing printer paper). The remaining problems required replacement of faulty equipment.

One equipment problem encountered frequently during the first half of the demonstration was loose cable connections. PRC technicians installed special clamps for the cables approximately mid-way through the demonstration, and the incidence of reported problems with connections declined thereafter. PRC technicians also began a program of preventive maintenance for store equipment in May 1985. This included periodic testing and cleaning of all equipment. The new clamps for the cable connections and the preventive main-

Exhibit 4-2

PROBLEMS WITH STORE EQUIPMENT

Problem	Resolved over Telephone	Technician Dispatched		Total
		Equipment Repaired	Equipment Replaced	
Printer	85	146	48	279 (46.7)
Terminal	30	57	32	119 (20.0)
Connections	82	22	14	118 (19.8)
Modem/phone	27	31	1	59 (9.9)
PIN-pad	0	7	13	20 (3.4)
Total	224 (37.6)	263 (44.2)	108 (18.2)	595 (100.0)

Source: EBT Center telephone problem logs.

tenance apparently succeeded in reducing the incidence of equipment-related problems. System operators received an average of about 44 equipment-related calls each month prior to May. Thereafter, the average dropped to about 33 calls each month.

EBT CARDS

Each retail store and recipient in the demonstration received one EBT card during training. These cards were replaced only if retailers or recipients reported them as lost, stolen or damaged. Exhibit 4-3 shows the frequency with which recipients' damaged cards were replaced during each month of the demonstration.

The incidence of damaged cards was fairly low during the first six months of the demonstration. Thereafter, however, the number of damaged cards increased. By the end of December 1985, 513 damaged cards had been replaced. The Berks County Assistance Office (BCAO) had issued approximately 7,200 cards by this time (including replacements for 468 cards reported lost and 79 cards reported stolen), so the failure rate for damaged cards over the 15-month demonstration period was about 7.1 percent.

Most of the EBT cards were issued by January 1985, the last month of mass training for demonstration recipients. Judging from the numbers in Exhibit 4-3, it appears that problems with damaged cards began about six months after card issuance. This six-month period is considerably shorter than the two-year durability factor reported for bank debit cards, and the incidence of damaged cards has created some concern for food stamp authorities involved with the demonstration. The Pennsylvania Department of Public Welfare (PDPW) plans to test a new EBT card in 1986 when it issues a second card to all participating retailers. The new card has a higher density magnetic stripe than the original EBT cards. Neither card is likely to be as durable as bank debit cards, however, because both cards use thinner plastic than the cards usually issued for use in automatic teller machines. The state did not originally select the card stock used for bank debit cards for two reasons. First, unlike bank debit cards, recipients' photographs are included on their EBT cards. Second, the selected cards are less expensive than bank debit cards. In an environment in which cards are reported as lost or stolen with some regularity, it may be more cost-effective to use cheaper cards. In

Exhibit 4-3

MONTHLY REPLACEMENT OF DAMAGED EBT CARDS

Month	Number of Cards Replaced	Cumulative Number Replaced
1984		
October	1	1
November	7	8
December	12	20
1985		
January	18	38
February	17	55
March	18	73
April	36	109
May	39	148
June	61	209
July	61	270
August	49	319
September	53	372
October	46	418
November	56	474
December	39	513

Source: Monthly reports compiled by the Berks County Assistance Office.

addition, Pennsylvania issued protective plastic wallets for cards issued to EBT recipients in an effort to reduce the incidence of damaged cards.

MANUAL AUTHORIZATION PROCEDURES

The manual authorization procedures implemented in the Reading EBT demonstration were generally quite reliable. Although two kinds of reliability-related problems were noted, they occurred infrequently.

The first reliability problem was lack of access to a person at the EBT Center who could authorize a manual purchase. A few retailers reported that when they called the EBT Center to request a manual authorization, the system operator said he or she was too busy to take the request. This occurred very rarely. Nevertheless, it points to one potential conflict built into the design of the Reading EBT system. Manual authorizations are most often needed when the system is experiencing problems. When the system experiences problems, system operators will necessarily be busy diagnosing and fixing the problem. The fact that the access problem occurred so infrequently reflects PRC's strong commitment to providing a high level of service to the retail community.

The second reliability problem is the overdraft -- that is, a manual sale authorized in excess of a recipient's remaining balance of food stamp benefits. As described in Chapter One, the system operator checks the previous night's listing of recipient account balances before authorizing a manual sale. If the recipient has made an EBT purchase since the report was generated, the recipient's actual remaining balance will be less than shown on the report. Depending upon the relative size of the true remaining balance and the manual sale, an overdraft may occur. Overdrafts can occur as well if the amount of a manual sale is miscommunicated when the store clerk calls the EBT Center for authorization. To reduce the possibility of large overdrafts, the maximum daily limit on manual sales in the Reading EBT system is $35 for each recipient.

No occurrences of overdrafts resulting from manual sales were clearly documented during the demonstration period. Early in the demonstration, one retail store reported a problem; the store never clarified the nature of the problem, however, and it is not certain whether a problem ever existed. Given the inability to access computer records when an EBT system is down, it

may be that no reasonable authorization procedures can completely avoid the possibility of overdrafts. The Reading experience, however, does not suggest that this is a matter of serious concern.

PROCESSING ACCURACY

The final element of system reliability is the accuracy with which the system processes purchase transactions and other system functions. Despite the fact the the EBT system in Reading processed 390,454 purchase and refund transactions, 50,686 benefit issuances, and 26,575 bundle-up transfers to retailers' accounts during the demonstration, very few errors in processing occurred.

Processing errors involving purchase transactions occurred only when the system failed while it processed such transactions. System failures occasionally led to a debit to the recipient's account but no corresponding credit to the retailer's account. System operators discovered these errors during daily system reconciliation and made appropriate adjustments to retailers' accounts thereafter.

Three errors occurred during the processing of issued benefits. In May 1985, the index structure on the Master File was out of sequence, and six recipients received incorrect benefit amounts from a supplemental issuance. Two of the recipients received too few benefits; the remaining four recipients received too many benefits. By the time that PRC identified the incorrect amounts and BCAO notified the recipients, two of the recipients had already used their excess benefits. PRC fixed the Update program which posts benefits to recipients' accounts the following week so similar errors would not recur.

The second error was not actually caused by the EBT components of the issuance system. In September, PDPW transmitted a duplicate supplemental issuance for 29 recipients five days after the original issuance. The county assistance office contacted the 29 recipients to recover the benefits issued in error.

The third error was quite large and immediately corrected. When running the Update program, the supervisor of the EBT Center noted a benefit amount in excess of $100,000. He immediately canceled the posting for that

recipient and contacted PDPW to determine the appropriate benefit amount. The source of the error was never discovered.

Finally, two processing errors involved grocery stores. The system incorrectly credited one store in September with approximately $600. PRC engineers were able to isolate when the funds were credited and which software programs were involved, but could not determine the cause of the discrepancy.

For the other store, the system lost track of ten day's worth of EBT sales immediately after the store began participating in the demonstration. The system is designed to place funds for new stores into a "pre-notification" account until the ACH network has sufficient information to transfer funds to the store's financial institution. At the end of the pre-notification period (which takes about ten days), the accumulated funds are transferred to a regular EBT account for the store and then transmitted to the ACH network. On the day the store's funds were to be transferred from its pre-notification account to its regular EBT account, the system failed during the transfer process. When the EBT Center restored the system, system files showed no funds in either the pre-notification account or the EBT account. Although the EBT Center manually adjusted the store's account so that full credit was received, PRC is uncertain why the error occurred.

The exact cause of three of the processing errors described above was never determined. PRC's problems in identifying the source of these errors points out the difficulties of fixing software problems which occur very infrequently. The potential for processing errors -- even after extensive software testing -- indicates the need for very thorough reconciliation of all funds in an EBT system on a regular basis. In addition, procedures should be in place detailing what actions the system operator and others need to take upon identification of a processing error. These actions include notifying the State Agency about the nature of the error and file adjustments needed, obtaining official authorization to make adjustments to file records, documenting all adjustments, and informing recipients or retailers of the error and the procedures being taken to correct the error (including adjusting debits to accounts or recoupment of unauthorized benefits already used, if necessary).

4.4 RECOMMENDATIONS WHICH SHOULD IMPROVE SYSTEM RELIABILITY

1) Specify performance standards for all elements affecting system reliability prior to system design.

The State Agency should specify performance standards for system reliability prior to system design. These standards should cover system accessibility, the reliability of store equipment, card reliability, the criteria for manual authorization procedures, and processing accuracy.

Performance standards for system accessibility should include the system's maximum allowable downtime. The experience in Reading and in other POS networks suggests that the maximum can and should be considerably less than one percent of normal operating hours. Because a system can be running but not able to process purchase transactions, however, performance standards should encompass more than just maximum downtime. They should be stated in terms of the percentage of attempted transactions which cannot be accomplished because the system is inaccessible for any reason. This protects against the problems which arise when a system is inaccessible for only short periods, but these periods occur when transaction volumes are high.

It is tempting to say that an EBT system should include a backup system to ensure high levels of system accessibility. Such a recommendation, however, goes beyond the realm of performance standards. System developers should have design flexibility, as long as the resulting system meets the requirements for system accessibility. The system may include backup processing capabilities, but with advances in computer technology backup systems may not be needed.

Performance standards for store equipment and EBT cards should be specified in terms of failure rates. The standards should include maximum allowable times to repair or replace faulty store equipment.

Standards for manual authorization procedures should include full accessibility of personnel to authorize manual purchases and a maximum acceptable level of overdrafts resulting from manual authorizations.

Finally, performance standards for processing accuracy should be very close to 100 percent. In addition, the standards should require the

presence of reconciliation procedures which can detect processing errors on the day they occur.

2) Thoroughly test all hardware and software which affect system accessibility and processing accuracy.

Once a prototype of an EBT system is developed, the system developer should subject the prototype to rigorous testing to ensure that all components of the system work as planned. At a minimum, all system functions to be performed in a normal operating environment should be tested. Because software errors often occur only under very specific combinations of circumstances (which usually cannot be predicted prior to implementation), the system software should be tested under as many different conditions as can reasonably be incorporated in a test environment.

3) System operators should be thoroughly trained before system implementation.

To reduce the likelihood that operator errors will affect system reliability, system operators should be well trained prior to system implementation. Training should cover not only all aspects of normal system operations, but procedures to follow when system problems develop. Operations manuals and reference materials for system hardware should be available, and system operators should know how to use these manuals and reference materials.

The qualifications and prior experience of system operators should reflect the qualifications and experience needed to operate the system. When new operators are hired, their training should include operating the system under the direction of experienced staff.

Chapter Five

SYSTEM SECURITY

Chapter Five

SYSTEM SECURITY

State Food Stamp Agencies issue billions of dollars in food stamp benefits each year: about $12 billion in fiscal year 1985. National, state and local agencies spend considerable resources trying to ensure that these benefits are protected against loss through either administrative error or fraudulent actions. If State Agencies implement EBT systems to issue food stamp benefits, the new systems will require at least as much security against administrative and fraudulent losses as the existing coupon issuance system.

5.1 GENERAL PERFORMANCE ISSUES

Performance issues for system security fall under two major categories: prevention of security problems and detection of problems when they occur.

PREVENTION OF SECURITY PROBLEMS

The prevention of security problems involves five separate performance issues: ensuring that only authorized personnel initiate EBT transactions, ensuring the integrity of legitimate EBT transmissions, ensuring the security of system files, protecting system accounts against overdrafts, and protecting recipient accounts against fraudulent conversion of benefits to food stamp coupons.

Protecting Against Fraudulent Initiation of EBT Transactions. EBT purchase and refund transactions initiated at store terminals are the only electronic mechanisms for transferring benefits between recipient and retailer accounts. An EBT system, therefore, should be designed to detect and reject any fraudulent transaction requests from store terminals. Fraudulent transaction requests could come from unauthorized customers using a lost or stolen EBT card to initiate a purchase transaction, from unauthorized store personnel using a legitimate store terminal to initiate purchase transactions, from authorized recipients using an outside terminal to initiate fraudulent refund

transactions, and from recipients and store clerks using a legitimate terminal in collusion to transmit a fraudulent refund transaction.

Protecting an EBT system against these actions requires three verification steps. First, the system must verify that the customer using an EBT card is either the legitimate holder of the card or an authorized representative of the cardholder. Second, the system must verify that the terminal transmitting the transaction request is a legitimate terminal located in a store authorized to participate in the system. Third, the system must verify that store personnel initiating transaction requests are authorized users of the equipment.

Protecting Legitimate Data Transmissions. On-line EBT systems transmit purchase transaction information over telephone networks. It is technically possible to intercept a telephone message, alter it, and then forward the message to the system. Any tampering with an EBT transaction message could change either the amount of the EBT transaction or the source or destination of benefits to be transferred. To ensure the integrity of legitimate EBT transaction messages, the system should be able to detect and reject any attempts to manipulate a transmission between the time it is transmitted from the terminal and the time it is received by the system. The system also should detect and reject any attempts to record a legitimate transmission for fraudulent replay at a later point in time.

EBT systems also may use telephone lines to receive issuance information from a State Agency or to transmit deposit information to either a financial institution or an electronic-funds-transfer network. As with transmitted purchase information, an EBT system should include features to ensure the integrity of these data transmissions.

Protecting System Files. An EBT system's computerized files are the repository of all information on recipients' benefits and retailers' EBT credits. The system updates these files whenever either the State Agency issues benefits, stores transmit EBT transaction information, or the system transmits stores' credits into an electronic-funds-transfer network for subsequent deposit to retailers' bank accounts. Protecting system files from unauthorized access, therefore, is a critical aspect of system security. The

potential for loss is very high if the files can be accessed and information within individual file records altered.

An EBT system must protect its computerized files from both external and internal unauthorized access. External access refers to individuals outside the system trying to use a computer terminal and telephone lines to the system to alter system files. Internal access refers to system operators (or other individuals with access to the system's computers) using the system's own computers to fraudulently manipulate file records.

Passwords are one common security feature used to protect system files against unauthorized access. Passwords enable activation of system programs which are capable of accessing system files. To be successful, passwords must be kept secure from unauthorized personnel. Periodic changes in passwords will increase their effectiveness.

Protection against internal unauthorized access may be especially difficult because operators will know the system and its passwords and may have legitimate reasons for accessing file records. For these reasons, detection of unauthorized internal access to system files may be as important as protecting against such access when designing a secure system.

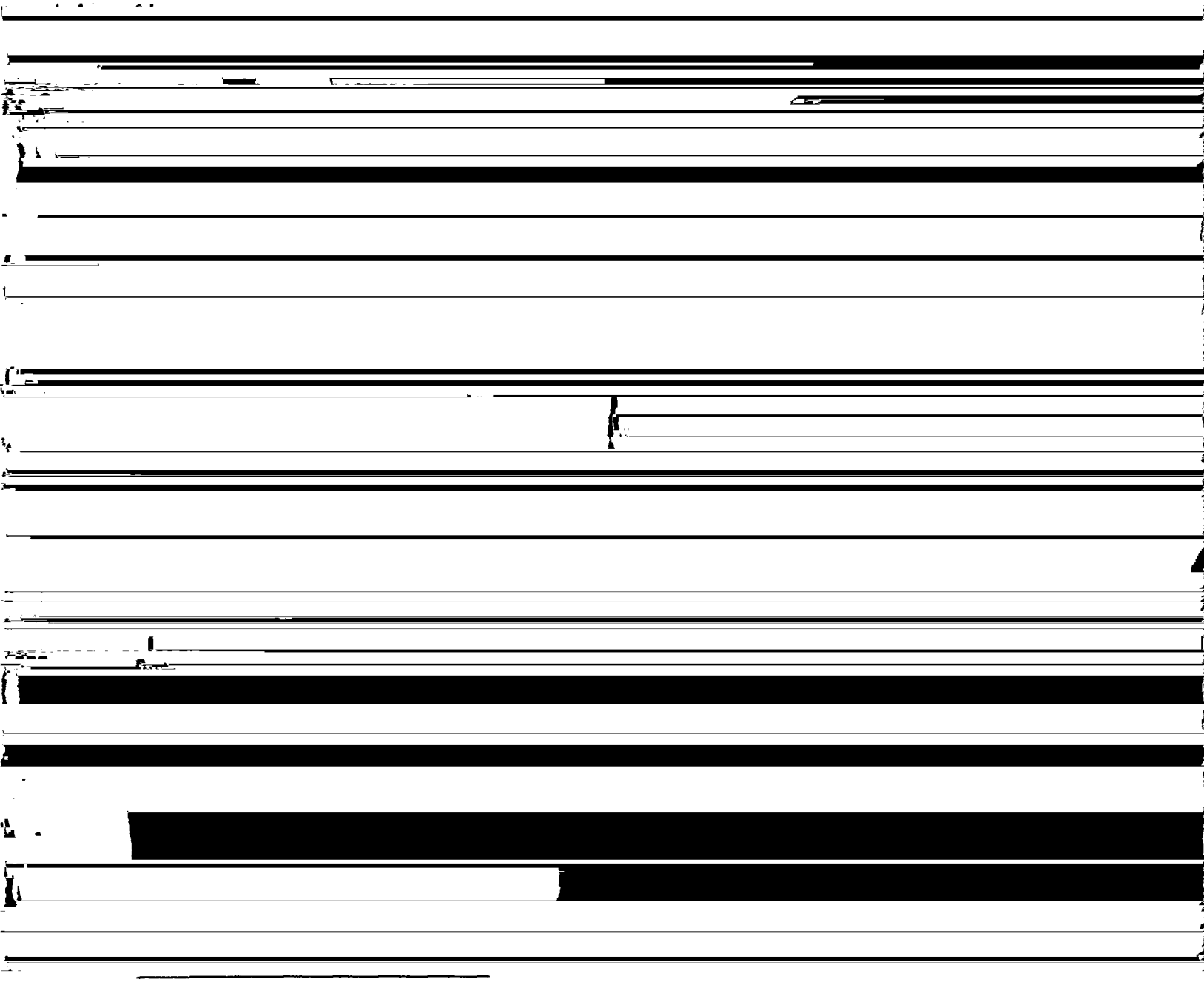
Protecting Against Overdrafts. Even if no fraudulent intent is present, an EBT system is not totally secure if overdrafts of recipients' accounts are possible. An EBT system should be designed, therefore, to prevent or minimize the possibility of either accidental or intentional overdrafts.

An EBT system is most vulnerable to overdrafts when the system is down and EBT sales must be manually authorized. As noted in Chapter Four, manually authorized purchases may bypass internal system checks against overdrafts. Manual authorization procedures should anticipate situations when overdrafts are possible and, insofar as possible, include manual checks which reduce the possibility of overdrafts in these situations.

Overdrafts also are possible if system processing is not totally accurate. Thus, system reliability with respect to processing accuracy affects system security as well.

Protecting Against Fraudulent Conversion of Benefits. In the absence of a national EBT system, a local or state EBT system must provide a

means of converting recipients' EBT benefits to food stamp coupons when recipients move to an area not served by an EBT system. The system is potentially vulnerable wherever the conversion is initiated. The system design must ensure that only authorized personnel at the welfare office can access the



The developer of an EBT system should recognize that breaches in system security are always possible. Thus, the system should be designed to detect and trace any security problems that occur. Reconciliation of system accounts and production of audit trail data should be used for this purpose.

Reconciliation of System Accounts and Flows of Funds. Flows of

Audit Trails. An EBT system should provide audit trails for all system functions which can change an account balance. At a minimum, the system should maintain a transaction file which records all movements of funds. The file should record the dollar amount, the time, and the source and destination of the transfer. For transactions initiated at store terminals, the transaction file should identify which terminal was used and the identification number of the clerk using the terminal. If system operators or local welfare office personnel can legitimately access system accounts, the transaction file should record their identification numbers as well. If system reconciliation detects any problems with account balances, this audit trail information will be needed to pinpoint the source of the problem.

5.2 PERFORMANCE STANDARDS FOR SYSTEM SECURITY

Improving the security of a POS system often requires special procedures or equipment. These procedures and equipment can increase system costs or make the system harder to use. Industry performance standards for system security are still under development. The general principle seems to be that system developers weigh the risks of reduced security against the costs of improved security when selecting a level of system security.

USE OF PERSONAL IDENTIFICATION NUMBERS

Requiring the use of Personal Identification Numbers (PINs) can improve the security of an EBT system by detering unauthorized use of lost or stolen EBT cards. There is currently some disagreement within the debit card industry, however, over whether PINs ought to be required in POS environments. Financial institutions tend to support the use of PINs to improve security. Some retailers, however, wish to avoid using PINs in POS systems because they require additional equipment (i.e., PIN-pads) and may create barriers to widespread debit card use. Potential barriers include the time required to enter and verify a PIN and customers forgetting their PIN codes.

Reflecting this divergence in viewpoints, the American Bankers Association is currently leaning towards adopting a policy which requires the

use of PINs at the point of sale.[1] In contrast, the Electronic Funds Transfer Association -- which represents the interests of retailers as well as financial institutions and other organizations -- has proposed draft guidelines which state that, "Use or non use of a PIN as part of the EFT-POS process is a decision to be made by cost/risk analysis."[2]

Both the Iowa and the Florida POS systems require debit card customers to use PINs to buy groceries. The Reading EBT system required demonstration recipients to use PINs to purchase groceries and to obtain account balance information. To further protect recipients' accounts against unauthorized access, store terminals in Reading allowed only three attempts to enter a valid PIN. This limitation was imposed to deter unauthorized persons with a lost or stolen EBT card from attempting to access benefits by trying random PIN codes. After three unsuccessful PIN entries, the terminal would send an "unsuccessful-PIN" message to the EBT Center. In this way the EBT Center could track possibly fraudulent attempts to gain access to a recipient's account.

DATA ENCRYPTION AND AUTHENTICATION CODES

An on-line EBT system transmits data messages over non-secure telephone lines. There is widespread agreement within the industry that, if a system requires the use of PINs, the PIN must be encrypted before transmission. Indeed, if the PIN-pad is not integrated with the terminal, the PIN should be encrypted before communication with the terminal. Industry standards for the method of encryption have been established.[3]

No standards appear to exist as to whether or not other transmitted data should be protected. Failure to provide some means of protection, however, renders data transmissions susceptible to interception and manipulation. Full encryption of all data transmissions offers the greatest security

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[1]"Implementation Guidelines for Online Debit Card Systems at the Point of Sale (Draft)," American Bankers Association, Payment Systems Policy Board, Retail Payments Task Force, Ad Hoc Committee, July 1986.

[2]Electronic Funds Transfer Association, "A Preliminary Look at the Voluntary Guidelines for EFT-POS Issues," Electronic Funds Transfer Conference, September 1985, p. 8.

[3]ANSI standard X9.8-1984 details the method of encryption.

for a POS system, but this protection is not without cost. Encrypted messages must be deencrypted before the data can be processed, and deencryption will slow system response times.

An alternate form of protection is the use of special authentication codes which are appended to the data message. Such codes, which are constructed at the point of origination of the message, are based on the data values to be transmitted. Once the message reaches its destination, the code can be reconstructed (based on the data received) and compared to the transmitted code. If the data have been altered either intentionally or through line transmission problems, the reconstructed code will not match the transmitted code and the message will be rejected.

Authentication codes are not as secure as data encryption because the informational content of the message can be interpreted if the message is intercepted. For this reason, PINs must be encrypted. Authentication codes, however, are easy to implement and do detect manipulation of transmitted data.

FNS GUIDELINES FOR SECURITY OF ADP SYSTEMS

Automated Data Processing (ADP) systems are used in administering many food assistance programs funded by the Department of Agriculture. In response to security deficiencies noted in these systems by the department's Office of Inspector General, FNS has issued guidelines to states for developing and administering computer systems involved in FNS assistance programs.[1] These guidelines are applicable to EBT systems as well.

The guidelines cover the following areas of system security:

- physical security,
- equipment security,
- software and data security,
- telecommunications security,
- personnel security,

[1] Food and Nutrition Service ADP Security Guide, United States Department of Agriculture, 1985.

- contingency plans,
- risk analysis, and
- emergency preparedness.

Performance standards within the above areas generally are not specified. Rather, the guidelines identify potential threats to security and procedures that should be considered to counter these threats. In the area of telecommunications security, for instance, the guidelines mention the encryption of sensitive data. For software and data security, the guidelines recommend changing passwords regularly, voiding access keys of departed users, monitoring user identification codes regularly, and documenting and controlling all changes to system software and operating procedures. The guidelines, therefore, are useful as a checklist of security issues to review when designing and implementing an EBT system.

5.3 PROBLEMS ENCOUNTERED IN THE READING EBT SYSTEM

PRC treated system security as a major design issue in developing the Reading EBT system. As a consequence, system security has generally been quite good. Nevertheless, some security problems did develop during the demonstration. For the most part these were problems with security procedures rather than problems which actually affected system files or transmitted data.

DECENTRALIZED AND SLOW RECONCILIATION

The Reading EBT system incorporated three major reconciliation functions: daily system reconciliation, weekly redemption reconciliation, and monthly issuance reconciliation. These reconciliation procedures successfully identified numerous account and system problems. The procedures themselves, however, posed their own set of problems for system operators and food stamp authorities monitoring the Reading demonstration.

System Reconciliation. Daily system reconciliation checks all flows of funds into, through, and out of the system against recipients' and retailers' current account balances.

Of the three reconciliation functions, system reconciliation presented the fewest procedural problems. PRC discovered and corrected a software error in the reconciliation program in January 1985. The error involved computation of life-to-date issuances from PDPW and life-to-date deposits to retailers' bank accounts. PRC also noted that the reconciliation reports did not include month-to-date conversions of EBT benefits to food stamp coupons (daily conversion amounts were included in the reports). The absence of this month-to-date information prevented automatic reconciliation of recipients' accounts after benefits had been converted. Rather than rewriting the program code, EBT Center operators manually reconciled out-of-balance accounts caused by benefit conversion. The manual procedures were feasible because the system processed, on average, only about 21 conversions of benefits during each month of the demonstration.

Redemption Reconciliation. Weekly redemption reconciliation was somewhat more problematic. Redemption reconciliation involved sending a tape each week to FNS' data processing center in Minneapolis. The tape included daily deposit information for each participating retailer and was designed to replace the reconciliation of redemption certificates which occurs under the coupon issuance system. The data center examined each tape to ensure that all retailers receiving deposits were indeed authorized to participate in the Food Stamp Program. The center also checked for unusual deposit patterns which might suggest fraudulent retailer activity. Finally, the data center compared total weekly deposits to retailers against weekly drawdowns of the Department of Agriculture's letter of credit with the United States Treasury. The Department of Agriculture implemented the letter of credit specifically for the purpose of reimbursing American Bank and Trust each day after the bank entered retailers' deposit information into the ACH network.

The Minneapolis data center occasionally found discrepancies between the weekly tapes and drawdowns against the letter of credit. Most of these discrepancies occurred because the weekly tapes either contained errors or were formatted incorrectly. Data errors on the tapes usually resulted when

the indices on the system's Master File were corrupted when the tapes were created.[1] In one instance the discrepancy occurred because American Bank and Trust had delayed entering retailers' deposits into the ACH network.

The major problem with the redemption reconciliation procedures was timeliness. Both the EBT Center's weekly tapes and the weekly drawdown information from the Treasury had to be sent to the Minneapolis data center before reconciliation could take place. The aforementioned problems with tape errors introduced delays in redemption reconciliation; the EBT Center often required several weeks to determine the source of the problem and to recreate and send a backup tape. Obtaining timely information about the drawdowns on the letter of credit was even more troublesome. Rather than having Treasury send the drawdown information directly to Minneapolis, national staff at FNS collected the information and then sent it on to the data center. They did not always obtain the information immediately, which delayed final reconciliation for that week's worth of deposits and drawdowns.

Although the above delays did not hinder the eventual reconciliation of retailer redemptions, they raised a concern among food stamp authorities. If, for instance, a retailer was fraudulently receiving excess EBT funds or if someone at the bank was requesting excess funds from the letter of credit, late detection of such problems might hinder the successful recovery of the funds. A secure EBT system should incorporate procedures for the timely detection of any security problems to minimize the risk of loss.

Issuance Reconciliation. The design of the Reading EBT system called for reconciliation of issuance amounts each month. Both the EBT Center and PDPW were to send national FNS staff reports indicating total EBT issuances for the month. National staff would then compare and reconcile the separately reported issuance amounts.

This relatively simple task proved to be quite troublesome. Through an apparent oversight during the design process, PDPW and the EBT Center used different monthly cut-off dates for their issuance reports. The different cut-off dates made reconciliation impossible. To counter this problem,

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[1]Problems with corrupted indices are described in Chapter Four, page 97.

national staff asked the EBT Center to provide copies of the summary sheets from the daily system reconciliation reports. These summary sheets indicated the total daily issuances from PDPW posted to recipients' accounts. National staff then reconciled the EBT Center's daily issuance reports with PDPW's monthly report. This approach was easier to implement than asking either the EBT Center or PDPW to redesign their software for the reconciliation reports, but it was more time consuming than the originally planned reconciliation procedure. Of greater concern, the new approach delayed monthly reconciliation of issuances. Three to four weeks often passed before the national staff received all the needed reports for a particular month. As with late reconciliation of retailer redemptions, late reconciliation of issuances to recipients decreases the possibility of full recoupment of overissuances by giving recipients more time to use the unauthorized benefits.

NON-ENCRYPTED DATA TRANSMISSIONS

All electronic transmissions of information to the EBT Center from either PDPW or the Berks County Assistance Office were supposed to be encrypted. The PDPW transmissions were for issuance of recipients' food stamp benefits. Transmissions from BCAO included information on card encoding, requests for balance levels or recent transaction activity, and changes in the status of recipients' accounts.

Despite the plans for data encrypting, most data transmissions from PDPW were not encrypted. PDPW's data encryption equipment was located under the floorboards of the department's computer center. Because issuance transmissions began with the non-encrypted telephone number of the EBT Center, this data encryption equipment had to be switched off and then on again for each daily transmission. PDPW decided not to encrypt most of their transmissions because it was so inconvenient to switch the equipment on and off.

In May 1985, PRC designed special circuits to eliminate the need to turn the data encryptors at PDPW and BCAO off and on manually. PRC installed the BCAO circuit in June, but never was able to test the circuit at PDPW.

OVERDRAFTS AND OTHER ACCOUNT PROBLEMS

One of the key objectives of system security is the prevention of overdrafts and other problems affecting system files and accounts. As dis-

cussed in Chapter Four, the Reading EBT system did experience some problems in this area. Most of these problems were attributed to software errors, however, rather than breaches in system security. The EBT Center and food stamp authorities detected the errors during the regular reconciliation procedures designed for the system.

NON-TRACEABLE CHANGES TO ACCOUNT FILES

The supervisor of the Reading EBT Center was able to change balance information in recipient and retailer records on the Master File without the system making any automatic record of the change. This represented a major design flaw in the system's security. All balance information in an EBT system should be fully auditable.

In practice, all changes to account balances were made only after the EBT Center had identified a data error and the BCAO had authorized its correction. Furthermore, for the system to balance during daily system reconciliation, parallel changes in the life-to-date fields of the reconciliation report had to be made, and these changes could be made only by programmers at PRC's headquarters. Thus, system reconciliation would detect the presence of any unauthorized changes made by the supervisor.

The ability to detect the presence of unauthorized changes during reconcilation may not provide full protection for an EBT system. If such changes are not automatically recorded by the system, tracking the source of any reconciliation discrepancies will still require the assistance of the system supervisor.

OTHER MANIPULATION OF ACCOUNT FIGURES

National FNS staff discovered one other instance of manipulation of account numbers during their weekly redemption reconciliation. As the system's clearinghouse bank, American Bank and Trust sent a wire funds request each day to the United State Treasury for reimbursement of funds taken out of its ACH account to cover retailers' daily deposits. After inadvertently requesting $.30 too little in one day's request, the bank added an extra $.30 in its next day's wire funds request.

Although American Bank and Trust was certainly entitled to the $.30, food stamp authorities expressed concern over how easily the bank had been able to request more money from Treasury than it had paid into the ACH network. Designers of future EBT systems may wish to consider stricter controls in this area.[1] It may well be, however, that this is an element of system security in which detection (through timely reconciliation) is sufficient to protect system security.

5.4 POTENTIAL PROBLEMS IN OTHER EBT APPLICATIONS

Many different security problems might develop in any EBT system. Those encountered in Reading generally related to procedures either for protecting the system (e.g., data encryption) or detecting problems (e.g., late reconciliation), or to non-fraudulent attempts to correct previous errors.

Based on current information, the Reading system seemed to be free of fraudulent attempts to initiate EBT transactions or to manipulate system data. Indeed, one PRC engineer expressed surprise over the absence of any attempts by computer "hackers" to penetrate the system. Other EBT systems may very well be subject to such attempts. Given the large potential for loss of benefits or for disruption of system functions if fraudulent actions were successful, EBT systems should be as secure as possible against such actions.

In a test to determine the Reading EBT system's vulnerability to unauthorized external access, an outside consultant attempted to access and manipulate system files. Using the telephone number for the system's computers, the consultant tried to log into the system and get a valid system response. If a successful log-on procedure had been completed, the consultant would have attempted to change information in the system's files. All attempts to log onto the system failed. The consultant noted, however, that an unauthorized person who knew the system's telephone number could tie up the

[1] An alternative and potentially more secure approach would have system operators create the ACH entry. With this approach the ACH would debit the Department of Agriculture's Food Stamp Program account at the Treasury while crediting individual stores' bank accounts, eliminating the need for a wire funds transfer. This approach was not used for the demonstration because the Department of Agriculture did not want a private contractor accessing its account at the Treasury.

system's telephone lines for a prolonged period (although this was not actually done during the test). If all telephone lines were tied up during busy shopping periods, the inconvenience to retailers and recipients could be great.

5.5 RECOMMENDATIONS WHICH SHOULD IMPROVE SYSTEM SECURITY

As noted at the beginning of this chapter, the security of an EBT system can be protected both through measures designed to prevent problems from occurring and through measures designed to detect (and elicit a reaction to) problems which have already occurred. The first three recommendations in this section are preventative measures. The last three deal with detection.

1) Perform a risk analysis of the proposed EBT system.

The first step in designing a secure EBT system is to perform a thorough risk analysis of the proposed system design. Risk analysis involves examining all aspects of an EBT design to determine its points of vulnerability. Once the potential vulnerabilities are identified, measures to counter these vulnerabilities should be developed and incorporated into the system design.

2) The system design should facilitate data encryption.

Risk analysis should indicate which data transmissions over non-secure telephone lines should be encrypted. The EBT system should include features which facilitate the encryption and deencryption of these data. To maintain proper levels of security, the system should identify and reject any data which are supposed to be encrypted but are not.

3) The system should require the use of PINs by recipients.

Despite the lack of agreement within the POS industry over use of PINs, requiring PIN entry at the point of sale to access food stamp benefits will improve system security. PINs will not only deter the fraudulent use of lost or stolen EBT cards by non-authorized customers, they will protect recipients' accounts against fraudulent access by retailers.

Retailers' misgivings over requiring PINs at the point of sale include concerns that customers will forget their PIN codes or that PINs will otherwise deter usage. The Reading EBT demonstration was somewhat atypical of normal POS systems because recipients had to use their EBT cards and PINs to access their food stamp benefits. Nevertheless, neither recipients nor retailers in the EBT demonstration reported any particular difficulties with recipients forgetting their PIN codes.[1]

Increased system security also may be achieved by requiring retailer PINs to activate store terminals. Terminals in the Reading EBT system were signed onto the system with special EBT cards, and store managers had to enter a valid PIN to complete the sign-on procedure. Such procedures protected against the fraudulent use of authorized store equipment.

4) The system should have complete and timely reconciliation procedures.

System reconciliation serves two purposes. First, it identifies processing errors which affect flows of funds through the system and system accounts. Second, it detects security problems arising either from fraudulent activity or improper system design.

To provide maximum protection, reconciliation procedures should encompass all flows of funds through the system. Purchase debits against recipients' accounts should be reconciled against credits to retailers' accounts. Benefits issued by the State Agency should be checked against recipients' remaining balances and funds transferred to retailers' accounts. These checks should be performed both for individual recipient accounts and for all accounts as a whole. If a special account is established to fund retailers' redemption of benefits (similar to the letter of credit in the Reading EBT system), reconciliation should include a comparison of retailers' total redemptions and drawdowns against the special account.

Reconciliation should be based on independent data sources. When a single data source is used, for instance, to compare both positive and negative flows of funds, any errors in that data source may be offsetting, masking the existence of the errors and negating the value of the reconciliation. In

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[1]For a more detailed discussion of this issue, see Hamilton op. cit.

Reading, for example, the system did not reconcile benefit issuances by comparing issuance data received from PDPW to benefits posted to recipients' accounts. Instead, recipients' posted benefits at the EBT Center were compared to an independent record of benefits issued by PDPW. Similarly, redemption reconciliation compared EBT Center data with data provided by the United States Treasury.

Redundancy in system reconciliation should be encouraged. That is, if two methods of checking a particular accounting relationship are possible, reconciliation should incorporate both methods. The daily system reconciliation in Reading provides an example. Not only were daily flows of funds reconciled against account balances, the reconciliation included month-to-date and system life-to-date reconciliation of flows of funds and account balances. Such redundancy provides double protection against both processing errors and security problems. Redundancy also may make it more difficult for system operators to fraudulently bypass system reconciliation in attempts to manipulate accounts or funds without subsequent discovery.

Reconciliation should be performed on a timely basis. The longer that errors or security problems pass unnoticed, the greater the opportunity for large or unrecoverable monetary losses.

Given the importance of reconciliation as a means of detecting processing errors and security problems, reconciliation procedures should be thoroughly tested prior to system implementation. All reconciliation software should be repeatedly checked for possible software errors, and the reconciliation procedures should be carefully evaluated to ensure that they provide full protection. All persons responsible for reconciliation should be completely familiar with the procedures and with what to do when reconciliation reveals account problems.

5) The system should have audit trail capabilities.

Reconciliation procedures can detect when system accounts are not in balance. By themselves, however, they may not be capable of identifying why accounts are out of balance. An EBT system, therefore, should provide mechanisms whereby all flows of funds and activities affecting account balances are recorded and auditable. Providing audit trail capabilities is a minimum

requirement of sound management practice for any system or organization handling valued assets.

The computerization of system files in an EBT system facilitates the maintenance of audit trail capabilities. Any system function which changes the amount of funds in any file record should be automatically recorded on a special file as the change takes place. Sufficient information about the change should be recorded so that, upon inspection, system operators or an auditor can determine why the change took place and who initiated the function causing the change. In Reading, for instance, the transaction file uses special codes to distinguish among separate system functions which can change recipients' or retailers' EBT account balances (e.g., purchase transactions, refund transactions, benefit issuances, benefit conversions to ATPs, deposits to retailers' bank account through the ACH network). The transaction file records the source of each change (i.e., a particular store terminal, PDPW, BCAO, or the EBT Center) and, oftentimes, the individual initiating the change. Store clerks and individuals at the BCAO have to enter identification codes before the system will accept data transmissions from these sources.

To maintain full audit trail capabilities, information about all manually authorized purchase transactions should be entered into system files as soon as the system is ready to process this information. Written documents supporting such manual transactions should be retained.

Finally, no individual should have the ability to access and change information within a system account file without the system making an automatic record of the nature and reason for the change and when the change was made.

6) System security should be reviewed and tested after system implementation.

Potential weaknesses in system security can often be identified by having somebody other than the system designer review security procedures. Although planned security procedures can and should be reviewed prior to system implementation, reviews should be performed after implementation to ensure that planned security measures are indeed being followed. Persons conducting the reviews should be familiar with the operations and security issues surrounding EBT or POS systems.

Further protection against potential security weaknesses can be gained by conducting tests which attempt to breach system security. These tests can simulate both external and internal unauthorized attempts to manipulate system data or files. Any problems revealed by security tests should be examined by the system developer or operator and, if needed, corrective counter measures should be implemented.

Chapter Six

SYSTEM MANAGEMENT INFORMATION

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SYSTEM MANAGEMENT INFORMATION

Transaction Times. At a minimum, an EBT system should provide periodic reports on how much time the system requires to process individual purchase transactions. These reports should separately indicate system processing times during peak-volume periods and at other times.

System processing time does not reflect total transaction time for EBT purchases. If a State Agency specifies performance standards in terms of total transaction times, total transaction times at store checkout counters need to be measured. This measurement can be time consuming and expensive, and it will not be cost-effective to measure total transaction time on a regular basis. After an initial measurement, however, the relationship between total transaction time and system processing time can be analyzed. Unless operating procedures at checkout counters change thereafter, the initial data can be used to estimate changes in total transaction times if system processing times change. If questions about system performance arise later, total transaction times can be measured again.

System Capacity. Limited capacity in the areas of processing, communications and storage will impair system performance. Information about utilization rates within each area is needed to monitor the adequacy of existing system capacity.

System operators should be able to provide most of the information needed to measure utilization rates. Examples include rates of usage of computer processing time, line usage figures, and available disk space for system files. As in the Reading demonstration, however, it may be necessary to collect additional information on communications capacity if all lines to the computer system are frequently in use. The local telephone network may be able to provide measures of how often store terminals cannot access the system because all lines to the system's computers are busy.

System Reliability. System reliability includes the amount of time the system is accessible for processing purchase transactions and the accuracy of all system processing functions.

One component of system accessibility is system uptime. If possible, the system should automatically record periods of system uptime (or, conversely, downtime) to facilitate this monitoring function. If the system cannot track system uptime automatically, system operators will need to main-

tain this information. For systems which are not staffed during all hours of operations, automated procedures for measuring system uptime should be available. A minimal requirement in this situation would be the recording of all attempted calls to the system which cannot be processed because the system is down.

As discussed in Chapter Four, a system can be inaccessible to retailers and recipients even when the system's computers are operating. A separate log of periods of inaccessibility can be maintained to provide needed information on the extent to which an EBT system is inaccessible for processing purchase transactions. If this log indicates both the time and duration of each period of inaccessibility, one can estimate the percentage of attempted transactions which cannot be processed. The estimation procedure requires using prior information on the percentage distribution of purchase transactions during all hours of a month.

Information on system accuracy requires an enumeration of all instances when inaccurate processing occurs. System reconciliation reports may identify all such instances. If system operators identify errors through other means and correct these errors before reconciliation occurs, however, the reconciliation reports cannot be the sole source of information on processing errors. Instead, procedures for logging information about identified errors will need to be implemented.

System Security. As with information on processing errors, information on problems with system security may need to be compiled from several different sources. System reconciliation reports provide an information source for problems which actually result in manipulation of system files or account balances. If system operators notice any attempts to access the system fraudulently, these attempts should be documented.

Monitoring individual transaction messages and patterns of transaction activity can reveal instances of actual or possible security problems. For instance, repeated attempts to use an EBT card with an invalid PIN may indicate fraudulent use of a lost or stolen card. Transactions originating from a store during non-business hours represent a possible security problem, as do transmitted security codes which do not match security codes calculated by the system. Transaction messages with invalid or incompatible store and terminal identification codes also suggest security problems.

System operators or the system itself should maintain a log of these instances, and system operators should investigate and determine whether actual attempts to breach system security are involved.

System security also is threatened when established security procedures are not followed. Examples include transmitting non-encrypted data which are supposed to be encrypted, not maintaining strict control over physical access to the computer center, failing to update passwords and other procedures authorizing access to system files and programs, and not documenting changes to system files or other events that could suggest possible breaches of system security. The system supervisor should have primary responsibility for ensuring compliance with all security procedures, but all system personnel should be responsible for identifying instances when security procedures are not implemented.

INFORMATION ABOUT SYSTEM PROBLEMS

The State Agency and system operators need to know when system problems occur. System operators must know about problems so they can remedy the situation as quickly as possible and return the system to normal operations. The State Agency needs information about problems to support its role in monitoring system performance. When serious problems develop, however, the State Agency must be informed so it can participate in any decisions about how the problems will be resolved.

Several different problem identification procedures are possible. Retailers and recipients can be instructed to call a special telephone number whenever they encounter system-related problems. System reconciliation reports can identify problems with processing errors and system security. System operators will be in the best position to identify problems which affect system operations.

Identification is only the first step in problem resolution. Once a problem is identified, the system must provide sufficient information for operators to determine the cause of the problem. System operators (and the State Agency, if necessary) can then take steps to correct the existing problem and to see that it does not recur.

Various sources are available to determine the cause of system problems. Simple inspection and diagnostic tests on store equipment can often identify why equipment will not work properly. Operator logs and audit trail capabilities can help trace the events leading up to the occurrence of a problem. Error messages on the system's computer console or in computer printout may indicate the nature of a problem, thereby suggesting its cause.

Diagnosing problems in system software can be especially difficult. When problems terminate system operations, it will be most helpful if the system identifies exactly what function was being performed at the time of failure. Such identification will pinpoint which software program is the likely source of the problem. It also will enable system operators to monitor the appropriate records carefully, when the system resumes operations, to ensure that the failure has not introduced any data errors into system files.

INFORMATION ABOUT SYSTEM COSTS

An EBT system is an alternative means of issuing benefits to food stamp recipients. It therefore encompasses one of the primary tasks of administering the Food Stamp Program. As a means of identifying and monitoring total program costs, information about system costs should be available to the State Agency.

System costs include equipment purchase or lease expenditures, space rental, telecommunications expenditures, staff salaries, and other direct costs. These costs may be borne either directly by the State Agency or through a contract with the system operator. If the State Agency contracts for EBT services, system costs may appear in the form of transaction fees.

Depending upon prior negotiations, it is possible that an EBT system may generate some revenues to offset system costs. For instance, retailers may pay a fixed initial or monthly fee or a fee per transaction to participate in the system. If revenues are generated, information about the source and level of these revenues should be included in the overall information provided on system costs.

INFORMATION ABOUT CHANGES IN DESIGN OR OPERATING PROCEDURES

Data processing systems usually undergo numerous small changes in design and operating procedures throughout their lifetime. Staff responsible for implementing these changes may leave at any time. For these reasons it is absolutely essential that any changes in system design, system software or system operating procedures be fully documented and communicated to the State Agency and to all system participants affected by the change. When changes to an EBT system are made, relevant sections of design and operating manuals should be revised and distributed. If needed, system operators and participants should be retrained in any new procedures.

Careful documentation of changes will avoid situations in which the documented EBT system does not match the system in place. If past changes were not documented and current staff do not remember why the changes were made or their exact scope, it can be nearly impossible to manage a system efficiently. In extreme cases, nobody in a position of responsibility for the system may know exactly how the system works. Without full knowledge of system functions, further changes or improvements cannot be implemented because the full consequences of any changes on other parts of the system cannot be anticipated.

INFORMATION ON SYSTEM USE

A State Agency may desire periodic reports on the nature and level of EBT-related activities. Examples are the number and types of participating retailers, the number of recipients trained each month, the number and dollar value of purchase and refund transactions, the number of transactions which are manually authorized, the percentage of benefits used each month, the numbers of recipients not accessing their benefits, and the incidence of PIN-entry problems and attempted purchases which cannot be completed due to insufficient balances.

This information may serve a variety of purposes. For example, documenting levels of system activity provides information about usage patterns in an EBT system which is not readily available through any other means. This information can facilitate planning for an expanded EBT system or for EBT systems in other locales.

The State Agency will want to know whether or not recipients are having problems when trying to use the system. A high incidence of PIN-entry problems may suggest that recipients have trouble remembering their PINs. A high incidence of transactions rejected due to insufficient balances may indicate that recipients cannot remember how to check their remaining balances prior to shopping. Accounts with large benefit amounts left in them may reflect the total inability of some recipients to deal with an EBT system at all. If further investigation reveals that any of these hypotheses are true, the State Agency will want to take steps to improve training or to otherwise assist recipients in accessing their authorized benefits.

Finally, some of the information can provide further evidence on system performance problems. Manually authorized purchase transactions, for instance, are needed only when the system is inaccessible to retailers and recipients. A large number of manual transactions, therefore, suggests problems either with store equipment or with the system itself. Similarly, potential capacity problems may exist if the total number of purchase transactions is greater than planned for in the system design.

6.2 PERFORMANCE STANDARDS FOR MANAGEMENT INFORMATION

General performance standards for system management information are straightforward. Management information should be complete, it should be accurate, and it should be timely.

The previous section enumerated many different types of management information needed by a State Agency and system operators. The absence of any of this information will impair system management. For instance, system performance cannot be fully evaluated without information pertaining to each performance standard specified by the State Agency. Non-identification of system problems or their causes will delay corrective actions, reducing system performance. Poor documentation of system changes may lead to a situation in which further system refinements or even resolution of later problems cannot be accomplished because no one fully understands how the system works.

The need for accurate management information requires little explanation. Incorrect information can mask poor system performance. Inaccurate information about system problems and their causes will delay efforts to

correct the real problems. Worse yet, decisions about corrective actions which are based on inaccurate information will consume scarce management resources and may be very costly to implement.

Finally, late information can delay the identification of system problems and poor performance. Inaction arising from late information may allow other, more serious problems to appear before corrective actions can be designed and implemented. For instance, software problems which allow small account errors to occur may, if not corrected, subsequently allow larger account errors to occur. Problems with high utilization rates of system file space eventually may terminate all system processing if the capacity problems are not recognized and corrected in time. Continued poor system performance which is unrecognized by system managers also may frustrate participating retailers and recipients. Such frustration may hinder efforts to successfully implement an EBT system which is supported by the retail community and by food stamp recipients.

6.3 PROBLEMS ENCOUNTERED IN THE READING EBT SYSTEM

The EBT Center provided a great deal of management information about the Reading EBT system during the course of the demonstration. The agencies and persons responsible for monitoring and evaluating the system, however, experienced many problems with this information. Some of the problems can be attributed to the demonstration nature of the project itself. For instance, uncertainty about what types of system problems might occur in an EBT system made it difficult to specify management information needs. The absence of performance standards also prevented a more targeted specification of required management information.

AMBIGUITIES IN REPORTED INFORMATION

One major source of management information is the end-of-month reports on system activities that the EBT Center provided to FNS and the evaluation contractor. These reports are designed to document levels of system activity and to identify potential problems which recipients might have with the system. Examination of some of the reports, however, revealed ambi-

guities that prevented conclusions about the incidence of certain activities and problems.

Incidence of Refunds. Refunds may be required in two situations in an EBT system. First, store clerks may transmit a purchase amount greater than the true amount, in which case a refund would restore the recipient's account to a proper balance. Second, recipients may return merchandise bought with EBT benefits and request a refund.

The end-of-month reports list the number of refunds processed each month. The numbers presented in the reports, however, overstate to an unknown degree the incidence of refunds arising from the two situations described above. This ambiguity occurs because when the system crashes in the middle of a purchase transaction or when store terminals time out before a purchase transaction is completed, the system corrects the recipient's account balance by posting a "refund" to the account equal to the interrupted purchase transaction. It is therefore impossible to identify with certainty the number of true refunds processed by the system.

Incidence of Problems with Insufficient Balances. The end-of-month reports present the number of attempted purchase transactions which are rejected because the purchase amount exceeds the recipients' remaining EBT balance. This information is useful in determining whether or not recipients have trouble keeping track of their remaining benefits.

The system, however, rejects a purchase transaction if the store clerk transmits an incorrect purchase amount which exceeds the recipient's remaining balance. Based on information in the reports, it is therefore impossible to determine how many of the rejected transactions reflect actual instances in which recipients tried to access more benefits than held in their accounts. Similarly, the incidence of clerk problems cannot be determined.

This particular reporting ambiguity cannot be attributed to specification failure or failure to implement information requirements. It arises simply from two actions having the same result. Reasonable reporting mechanisms cannot distinguish such actions under these circumstances.

Incidence of Problems with PIN Entry. Recipients must enter a valid PIN whenever they purchase groceries or obtain balance information from a

store terminal or a balance-only terminal. If a valid PIN is not entered within three tries, the terminal sends a message to the EBT Center.

The end-of-month reports list the number of invalid-PIN messages received by the EBT Center each month. The reports, however, do not distinguish between problems occurring at balance-only terminals and problems encountered at the checkout lane, even though the system can identify the source of all terminal messages. Because PIN problems at the checkout lane will delay other checkout procedures, being able to identify these latter problems would be useful in assessing the full impacts of the EBT system on retail operations.

Definition of a Month. The Food and Nutrition Service expected the end-of-month reports to provide enough information about individual account activity to enable manual reconciliation of changes in account balances with account activity. This reconciliation proved to be impossible as a result of ambiguities in what constituted a "month" for the system. Some of the end-of-month reports present calendar month activity; others reflect activity from the start of one "issuance" month (typically about the fourth workday of the calendar month) to the next. The lack of a uniform definition for a month prevented useful comparisons of information from one series of reports to another.

The lack of internal consistency in the end-of-month reports was very frustrating for anyone attempting to use the reports to understand or document system activities. PRC could not easily correct the problems because the end-of-month reports are based on information contained in two system files -- the History File and the Master File. The structure of these files and the system's programs for producing the reports could not easily support the adoption of a single definition for a reporting month.

As noted in Chapter Five, different definitions for a month also made issuance reconciliation reports impossible to interpret. The EBT Center and PDPW based their monthly issuance reconciliation reports on different reporting cycles. Food stamp authorities had to rely on summaries of daily reconciliation reports to overcome this reporting difficulty.

INFORMATION NOT REPORTED ON A ROUTINE BASIS

As the demonstration progressed and system performance problems developed, food stamp authorities sometimes needed information which the system was not providing. Examples included the incidence and duration of system downtime, the incidence of busy signals when store terminals attempted to transmit purchase data to the system, and system processing times for purchase transactions. Furthermore, after the addition of the seventh telephone line to the system's computers, the system did not provide routine information on the use of the seventh line and special information was desired on that point.

Food stamp authorities had asked PRC at the beginning of the demonstration to report regularly on system downtime and the incidence of busy signals. PRC began providing monthly reports on system downtime only after FNS made additional requests for the information. PRC said that the incidence of busy signals could not be measured. After several months of system operation, however, PRC discovered that the telephone company could provide special reports on the incidence of busy signals. PRC requested only two of these studies (each covering a period of approximately one month) from the telephone company, in part because the second study indicated few problems with a high incidence of busy signals.

INACCURACIES IN REPORTED INFORMATION

Most of the management information the Reading EBT system provides is accurate. In some cases, however, examination of reported information revealed inaccuracies. Upon investigation, PRC traced most of these inaccuracies to problems with the software producing the reports.

System downtime reports also failed to provide completely accurate information. Problems with accurate reporting of system downtime can be attributed to the absence of information-gathering procedures designed specifically to identify system downtime. PRC had to review detailed and voluminous daily logs kept by system operators. Any information-gathering procedure which relies on manual inspection of large quantities of data is likely to be prone to accuracy problems.

Finally, the weekly redemption reconciliation tapes the EBT Center sent to FNS' Minneapolis data center sometimes contained inaccurate information. These errors occurred primarily when the index structure of the system's Master File was out of proper sequence. When notified of problems with the weekly tapes, the EBT Center investigated the source of the problems and provided the Minneapolis data center with new tapes free of data errors.

LATE REPORTING OF INFORMATION

The Reading EBT system had problems providing some management information on a timely basis. The major problems occurred with reconciliation reports and the end-of-month reports.

Reconciliation Reports. As just noted, the EBT Center occasionally had to recreate redemption reconciliation tapes when the original tapes were inaccurate. The process of identifying problems with the original tapes, communicating this information from the Minneapolis data center to the EBT Center, investigating the source of the problems, and producing new tapes often required several weeks. These delays prevented timely reconciliation of retailers' EBT redemptions.

Monthly issuance reconciliation also was delayed when FNS discovered that the PDPW and EBT Center monthly reports could not be compared. Although FNS decided to use daily summaries of system reconciliation reports to replace the EBT Center's monthly report, this alternative procedure introduced delays in the reconciliation process. Food stamp authorities had to wait until the EBT Center compiled, photocopied and mailed a full month's worth of daily summaries before beginning each month's issuance reconciliation.

End-of-Month Reports. The EBT Center often could not provide a complete set of end-of-month reports until three to four weeks after the end of a month. Limited system processing capacity was responsible for these delays.

The first step in the production of end-of-month reports is the creation of a large, specialized data file containing all the information needed for the reports. Once the EBT Center creates this file, numerous report-generation programs need to be run against it. Both the report-generation programs and the file-creation program require batch processing by

the system. These programs require so much time to run on the system's computers that they were scheduled only on weekends when other processing demands were low. Limiting report production to weekends created the three- to four-week delays.

6.4 RECOMMENDATIONS WHICH SHOULD IMPROVE MANAGEMENT INFORMATION

Management information for an EBT system should be complete, accurate, and reported on time. The following recommendations are designed to help ensure that an EBT system meets these performance standards.

1) Specify needed management information before system design.

Once an EBT system is designed and implemented, it may be difficult to respond to new requests for information about system activities or system performance. System files may not contain the desired information. Even if the information is available, implementing efficient report-generation procedures may be difficult. Existing report software may need to be rewritten, and the existing file structure may need to be reorganized to support the information request. For these reasons, information requests should be specified prior to system design. The system developer then can incorporate information requirements directly into system report software and system monitoring procedures.

Minimum information requirements should include any data needed to evaluate system performance relative to specified performance standards. The system developer and State Agency also should attempt to predict likely problems which may impair system performance. Insofar as possible, the system should be designed to identify the incidence and cause of these problems as they occur. This latter information will enable more rapid response to system problems, thereby improving overall system performance.

2) Thoroughly test all reporting software and procedures before system implementation.

Software errors and incorrect data-gathering procedures are likely to be the primary causes of problems with information accuracy. Thorough testing of report software prior to system implementation can identify soft-

ware errors before they begin to affect information reported during system operations. Similarly, early review and testing of manual procedures which gather and compile information for management reports can identify areas in which errors may be introduced.

Software testing should be based on specially prepared data files with known content which replicate the organization and structure of actual system files. Because the content of the test files is known, information in the management reports can be checked against expected report information to identify software errors. If the management reports for a given period need to track and compare system activities and account balances over multiple reporting cycles, the software testing should include multiple reporting periods as well.

Possible sources of errors in manually compiled reports include both the raw data and the procedures for compiling the data. Once the accuracy of the raw data is confirmed, the system developer should review both the logic and the ease of compiling the raw data. If possible procedural problems are identified, the developer should try to design easier reporting procedures. Automating manual compilation procedures can reduce the potential for error.

3) Review the system's ability to provide management information on appropriate schedules.

As information requirements for system management are established, the State Agency should specify how often and when the required information should be provided. The system developer then needs to review both the system and personnel resources needed to respond to these information requirements. Based on resource demands for providing management information, system operating procedures should be designed to meet the schedules for management information. In particular, competing demands from reporting requirements and from other system functions should be identified and resolved.

Chapter Seven

SYSTEM INTERACTION WITH USERS

Chapter Seven

- minimum number of codes or commands to memorize for the transaction;
- clear training, instructions, or in-process prompts;
- passive access to account balance information (information comes to the consumer rather than the consumer seeking it out); and
- clear and comprehensive account balance information.

Food stamp recipients need these same characteristics in an EBT system.

Food stamp recipients, however, differ in some potentially important respects from POS consumers. First, POS consumers make their own decisions to use or not use the system, while food stamp recipients are required to use the EBT system in order to receive their benefits. People who find (or expect to find) the POS system confusing or threatening can avoid using it. The EBT system must provide training or other system features to accommodate food stamp recipients who feel this way.

Moreover, the demographic profile of food stamp recipients suggests that they would have more trouble with a complicated or demanding system than would the population as a whole, let alone the typical POS consumer. Among the recipients participating in the Reading demonstration:

- 29 percent had no more than an eighth grade education,
- 27 percent said that their primary language was not English (all but a handful of those spoke Spanish),
- 17 percent were at least 60 years old, and
- 23 percent said they had a physical disability.

An EBT system must therefore be easy not only for a sophisticated consumer to use, but also for people with physical, educational, and language limitations.

GROCERS

Food retailers also want an EBT system to be easy to use, although ease of use is not their first concern. The retailer focuses first on factors that determine how long it takes a customer to get through the checkout

process. This includes the average duration of a normal EBT purchase and the frequency and severity of problems (see Chapter Two). Once satisfied on these points, the grocer becomes concerned with ease of use.

An easy-to-use system, from the retailer's point of view, has characteristics very similar to those noted for recipients:

- minimum number of separate actions to perform a normal purchase transaction;
- minimum number of procedures for cashiers to remember;
- clear training, instructions, or in-process prompts;
- simple backup procedures when electronic purchases are impossible;
- timely information on bank deposits resulting from EBT purchases; and
- deposit information readily comparable to information normally maintained in the store.

As in the case of recipients, it is important to distinguish between the stores participating in an EBT system and the supermarket and convenience chains that have been the early participants in POS systems. Current Food Stamp Program rules allow virtually any establishment to participate if staple food items comprise over 50 percent of eligible food sales. The bulk of the participating stores are small and medium independent groceries. Many participants do not fit a "grocery store" image, though. They include farm stands, milk routes, various operations in which retail food sales are a secondary activity, and even drug and alcohol treatment programs. The establishments participating in the Reading demonstration illustrate this diversity, as shown in Exhibit 7-1.

The Food Stamp Program encourages this broad range of food retailers to participate in order to provide recipients with all possible opportunities to redeem their benefits for food. This objective does not change under an EBT system. Hence, if nearly all currently participating retailers would want to participate in an EBT system -- and the Reading experience indicates that they would -- the EBT system must provide ease of operation in a broad variety of physical and economic environments.

Exhibit 7-1

TYPES OF RETAIL ESTABLISHMENTS IN THE READING DEMONSTRATION

FNS Category[a]		Stores in Demonstration[b]		Percent of Total	
Supermarket		24		15%	
Grocery store	[c]	46	87	28	53%
Specialty food		41		25	
Convenience store	[d]	15	24	9	15%
Combination/Gas		9		6	
Combination/Deli	[e]	1	27	1	17%
Combination/Merchandise		11		1	
Combination/Other		15		9	
Produce stand		5		3	
Health food		2		1	
Milk route		1		1	
Other firm		2		1	
Total		162		100%	

Notes:

[a] All establishments authorized to participate in the Food Stamp Program are categorized. Fourteen categories are not represented in Reading (the fourteen account for less than two percent of food stamp redemptions nationwide).

[b] Includes all stores for which any data are available, including some that were in the demonstration only briefly (e.g., because they opened for business late in the demonstration period).

[c] Grouped in subsequent discussion as "grocery stores."

[d] Grouped as "convenience stores."

[e] Grouped as "other stores."

7.2 PRACTICES IN POINT-OF-SALE SYSTEMS IN THE RETAIL FOOD INDUSTRY

Most concerns about an EBT system's ease of use are equally applicable to a commercial point-of-sale system. To provide a base for comparison, this section describes system features and procedures of the Florida and Iowa POS systems we visited. The discussion again considers the two main user groups, the consumer and the merchant.

CONSUMER FEATURES

Customer acceptance and use of POS systems is the critical factor that makes them profitable or unprofitable. Accordingly, great pains are taken to make the systems easy to use. Everyone we interviewed in the Florida and Iowa systems believed those systems are easy to use, and reported that customers hardly ever had difficulties.

Purchase Procedures. In the Florida and Iowa POS systems, the customer indicates that he or she wants to make a debit card purchase when the cashier finishes ringing up all of the items. After specifying whether the debit should be made against a checking or savings account, the customer must pass the debit card through the card reader and enter the PIN. The terminal then displays the amount of the purchase which will be debited to the customer's account. The customer presses an "ENTER" button. After processing, the terminal indicates that the purchase has been authorized or rejected and, if it has been authorized, a receipt is printed.

The customer thus has four responsibilities: specifying the account to be debited, passing the card through the reader, remembering and entering the PIN, and agreeing to the amount of the debit by pressing "ENTER."

The most difficult or inhibiting aspect of this procedure is the need to remember and enter the PIN correctly. POS system designers have debated the PIN requirement partly for this reason. A few debit card systems omit the PIN, feeling that gains in customer acceptance (and lower equipment costs) will offset the higher security risk. More commonly, however, the PIN is required. The draft POS standards formulated by the banking industry

specifically require PIN verification, suggesting that this may continue as a common practice.

Training and Instruction. Little formal effort is devoted to training or providing instructions for the customer in how to use the POS system. The banks issuing debit cards assume that customers will mainly use them for ATM transactions. Literature provided with the card, therefore, tends to focus on this usage. It generally falls to the cashier to give any supplementary instruction the customer may need to make a POS purchase. Store managers in Florida and Iowa said that very little such support was necessary, largely because most POS customers have previously used ATMs.

Stores promoting POS usage sometimes carry out more intensive efforts. As POS terminals were installed in the Publix supermarkets in Florida, cashiers were trained to respond to offhand customer inquiries ("What's that thing?") by explaining in detail and encouraging the customer to try out the system.

Account Balance Information. Customers receive an account of POS usage in their monthly bank statements. The statements record credits to the account and other debits against it, as well as POS activity.

Receipts from POS purchases do not typically provide information on the customer's current balance. In the Florida and Iowa systems, the receipt indicates the amount of the purchase and identifies the account debited (i.e., savings or checking). Customers in both systems can find out their current balance by using ATMs in the supermarkets.

Most banks participating in POS systems establish a daily limit on the total value of a customer's POS purchases, a limit which is usually lower than the customer's balance. The limit varies by bank, and many banks have different limits for different customers.

Customers do not generally receive information on the amount remaining in their daily allowable POS limit. They can keep track by subtracting the value of POS purchases during the day (which is recorded on the receipts) from the daily limit. If customers in the Florida and Iowa systems attempt a purchase that would exceed the daily limit, the transaction is rejected. The customer, however, often may not be told the reason for rejection. Some

stores refuse to have store personnel in the position of telling customers that they have exceeded their daily limit.

Special Needs. POS systems do not normally include features specifically oriented to supporting the needs of customers with physical, educational, language, or other limitations. Card-issuing banks that have substantial Spanish-speaking customer populations may provide descriptive materials in Spanish. In general, however, customers have the responsibility for finding any support that the cashier cannot readily provide.

POS customers may allow other persons to use their cards simply by giving them the card and PIN. The systems have no identify verification beyond the PIN check.

RETAILER FEATURES

Normal Electronic Purchase. Although procedures can vary, the Florida and Iowa systems handle normal POS purchases almost identically. When the cashier finishes ringing up the purchase, he or she asks how the customer wishes to pay. If the customer wishes to use a bank card, the cashier presses a key on the cash register. The customer passes the card through the reader, enters the PIN, and presses the ENTER key. The cashier then places a receipt form in a printer on the side of the cash register, and presses a key to begin the transmission. When the transaction is complete and the receipt printed, the cashier removes the receipt, gives one copy to the customer, and keeps the other copy for store records.

The cashier thus has four responsibilities in the normal POS purchase: pressing a savings or checking account key to identify a POS transaction, placing the receipt blank in the printer, pressing the key to begin transmission, and removing the receipt and distributing the copies appropriately. Cashier actions are the same in a rejected purchase, except that the cashier also may have to explain to the customer why the purchase was rejected (rejection reasons are displayed only as a number code).

No special action is taken to "sign on" a cash register to the system. The POS function is simply one of the cash register functions that becomes available as soon as the register is appropriately opened for operations.

The procedures described above apply only when the POS terminal is integrated with the cash register (which is the case in the supermarkets in both Florida and Iowa). Smaller stores in the same networks do not have integrated terminals. In these systems, the cashier must key in the amount of the purchase, and procedures for handling the receipt vary according to the printer being used.

Backup Procedures. If a POS purchase cannot be completed, either because the purchase is rejected or because the system is not functioning, the customer usually pays for the purchase in cash or with a check. Stores in both systems sometimes use a "store check" for backup. This is a check made out to the supermarket, in which the customer fills in the name of the bank, the account number and the amount of the purchase, and then signs the check. Because this procedure entails a risk that the store will not actually be able to draw against the customer's account, it is used only when the customer has no checks and not enough cash for the purchase. Even then, the store manager has the authority to refuse to use the store check and simply not to complete the transaction.

Refund Procedures. When a POS purchase results in the need for a refund, stores usually give the customer cash. The Iowa system has no procedures for an electronic refund, although a customer could take cash to an ATM in the store and make a deposit to his or her account.

A cashier could make an electronic refund in the Florida system by virtually the same procedures used for a purchase (a different key sets up the transaction). No special authorization or store card is needed for a refund. Rather than use this procedure, however, cashiers are instructed to give cash refunds. Management feels that customers prefer the cash, and having only a single POS procedure in use helps limit mistakes.

Reconciliation. The process through which a POS sale results in a credit to the grocer's account typically leaves records in four locations:

- purchase receipts retained at the cash register,
- transaction records retained in the store's processor,
- transaction records retained by the network, and
- bank records of deposits received.

Grocers reconcile their accounts by comparing data from various pairs of these points.

Headquarters staff of the grocery chains perform the major daily reconciliations in the Florida and Iowa systems. Representatives of the Iowa grocery chains said that their banks also perform some reconciliation functions. The Florida network provides daily listings and summaries of transactions by terminal and by store for all stores in the Publix supermarket chain. Chain staff compare these reports to reports generated by the store processors. In addition, store personnel reconcile the purchase receipts against the store reports, and network personnel check their summaries against bank reports of deposits received.

No "typical practice" seems to exist for defining the banking day. The Publix network in Florida, which serves only the Publix supermarkets, uses a midnight to midnight cycle. However, the Publix chain also participates in the Honor network, which has a banking day of 5:00 PM to 5:00 PM. The Iowa network uses a 6:00 PM to 6:00 PM banking day. Because reconciliation reports are generated in considerable detail from computerized data, none of the people interviewed felt that the difference between the banking day and the stores' business day posed any difficulty.

7.3 PROBLEMS ENCOUNTERED IN THE READING EBT SYSTEM

For the most part, recipients and grocers responded favorably to the EBT system in Reading. Indeed, the strength of positive feeling was a major factor in the decision to have the Pennsylvania Department of Public Welfare take over and continue operating the system. Even so, some aspects of the system presented difficulties for recipients and grocers. These are described here.

FEATURES AFFECTING RECIPIENTS

Judged either by the recipients' own responses or by comparison with the commercial POS systems, the Reading system appears to have been quite easy for recipients to use.

Recipients reacted extremely positively to the EBT system. In a survey conducted shortly after the recipients began using the system, 74 percent said they preferred the EBT card to the previous coupon system and only 21 percent preferred coupons. Responses to the same question six months later were even more favorable: 77 percent preferred the card, while only 17 percent preferred coupons.

Asked what they liked best about the EBT system, recipients most often said that it was easier than the coupon system, particularly at the checkout counter. Only a very small percentage said that they had ever had problems such as forgetting their PINs or their account balance. Surveys of grocers corroborated the recipients' view; they felt that recipients had no serious problems with the system.

An examination of recipients' responses by demographic groups found all of them preferring the EBT system. Surprisingly, groups that might be expected to have trouble with an EBT system actually tended to be more positive than average. The proportion preferring the EBT system was above-average for recipients with no more than an eighth grade education (81 percent), Spanish speakers (80 percent) and those reporting some disability (87 percent). Recipients aged 60 and over were slightly less strong in preferring EBT, but even among this group 73 percent preferred cards and only 11 percent preferred coupons. Clearly, none of these groups encountered serious difficulty in using the EBT system.

Most EBT system features affecting recipients appear at least as easy to use as the analogous features of POS systems. Recipients actually had fewer responsibilities in a normal EBT purchase transaction than did Florida or Iowa POS customers. Cashiers in Reading passed the EBT card through the reader and pressed the key initiating transmission; customers did this in Florida and Iowa.

EBT recipients received about an hour of training in using the system, including a videotape presentation and hands-on practice with the terminals. Community service groups (e.g., Catholic Service Agency, Berks County Association for the Blind) were trained to help recipients having problems with the system. No such training or support was available to POS customers in Florida or Iowa.

Account Balance Information. Tracking their account balance was probably the most difficult feature of the EBT system for recipients, though even this does not seem to have posed serious problems.

The EBT purchase receipt printed out the recipient's remaining account balance. Recipients mainly kept track of their balance through the receipt: over 90 percent said this was the primary way they knew their balance. Recipients also could find out their current balance by the following procedures:

- using any touch-tone telephone (the recipient dials a special number and keys in the account number and PIN, and a synthesized voice responds with the account balance),
- using the balance inquiry terminal available in larger stores only (the recipient passes the card through the reader and keys in the PIN, and the account balance is displayed), and
- using a terminal at the checkout counter (the recipient follows the same procedures as at the balance inquiry terminal).

Problems with the voice synthesizer hardware meant that the phone-in option was not always available. This may have caused recipients to rely more on receipts than would otherwise have been the case. The fact that only 42 percent of the recipients had touch-tone telephones also may have limited recipients' use of this system feature.

Recipients received no printed notification of benefits issued to their account. The welfare agency provided initial information on the amount of benefits the recipient could expect to receive each month, and the date on which the benefits should be credited.

The EBT system provided no routine, comprehensive statement of account activity. If recipients wanted to know whether the correct amount had been issued to their account or whether unauthorized deductions had been posted, they had to go to the welfare office. A clerk there could access the EBT Center computer files to get a list of all transactions recorded for the recipient's account.

Recipients did not consider the absence of monthly statements and issuance notifications a serious problem. In fact, 64 percent agreed with a statement that "it's easier to keep track of how much you have left with cards than with coupons." It is possible that the phrasing of the question leads to an overestimate of the proportion who actually like this feature of the EBT system. Still, it appears that most recipients were content with the information they received.

Comparing the information mechanisms of the EBT and POS systems, it is not clear which the customer would consider more convenient. The POS systems provide comprehensive monthly statements, a clear advantage for the individual who wants to be sure the account balance is correct. But the EBT system offered much easier access to the running balance, an advantage for people who want to know how much they can afford to buy today.

Data on purchases rejected for insufficient balance give rise to some suspicion that balance tracking is more of a problem than EBT recipients reported. Rejections for insufficient balance ranged from 2.6 to 4.2 percent of all EBT purchase transactions each month. This appears to be substantially higher than the incidence of balance problems in the POS systems, although exact comparisons are difficult. (One of the Iowa supermarket chains indicated that rejections for all reasons amounted to less than 1 percent of purchases; the Florida chain estimated rejections for insufficient balance as substantially under 2 percent.)

Insufficient-balance rejections are not entirely comparable in the EBT and POS systems. It is reasonable to assume that few POS customers consciously try to use every bit of their available balance (or daily limit). Demonstration recipients, however, often used all of the food stamp benefits they were issued each month. Many of the EBT system's insufficient-balance rejections apparently occurred as recipients were trying to use up the last of their monthly benefits. Even so, because rejections can slow up the checkout process, their relatively high frequency in Reading represents a problem that might be addressed by better balance information or different system procedures.

FEATURES AFFECTING GROCERS

Like the recipients, food retailers in Reading responded warmly to the EBT system. In March 1985, when the system had been operating about five months but was still encountering peak-load slowdowns, 74 percent of the grocers said they preferred the EBT system to the coupon system, while 26 percent preferred coupons. By October, after adjustments relieved the peak-load problems, 66 percent of the grocers preferred EBT, only 15 percent preferred coupons, and 19 percent expressed no preference (grocers were not offered the "no preference" response category during the earlier survey).

The level of enthusiasm for the EBT system depended somewhat on the type of store. Supermarkets were most favorable, with 79 percent preferring the EBT system in October and only 5 percent preferring coupons. Grocery and specialty food stores were least favorable, but even among this group 59 percent preferred EBT compared to 27 percent for coupons -- a two-to-one majority. Thus, although their differing needs caused them to respond differently on particular issues, all major store groups showed strong majorities in favor of the electronic system.

Grocers particularly liked the EBT system for its ease of use compared to the usual coupon redemption procedures. Specifically, the EBT system eliminated a series of handling steps required for coupons (to redeem coupons, the grocer must cancel each coupon, count and bundle them, fill out a Redemption Certificate, and take them to the bank for deposit). Some grocers also cited a convenience factor in the normal purchase process. If a recipient requires change for a coupon purchase, all change over 99 cents must be given in food stamp coupons, which are typically kept in a separate part of the cash drawer and may not be in sufficient supply at a particular register. In contrast, grocers gave no change of any form for EBT purchases.

The grocers' statements about the ease of EBT purchases were based on a comparison with coupon purchases. When we compared EBT procedures to those of the POS systems, which supermarket personnel also considered easy to use, the two systems seemed about equally easy. The EBT cashier had to swipe the customer's card, key in the purchase total, and press the "SEND" key to begin transmission, responsibilities the POS cashier did not have. On the other hand, the POS cashier had to put the blank receipt in the printer and, after printing, separate the copies, hand over the customer's copy and put the

store copy in the cash drawer. The EBT cashier simply tore off the printed receipt and gave it to the customer.

While the normal EBT purchase was easy, the EBT system had some less convenient features. Some of these features were raised by grocers as important issues, although not important enough to alter their overall preference for the EBT system. These features are discussed here.

Financial Reconciliation. Grocers strongly criticized the EBT system's mechanisms for providing information about deposits to their account. Near the end of the demonstration, grocers were asked about a series of eleven possible system improvements, ranging from getting rid of slowdowns to getting more telephones or having better training for recipients. Two of the possible improvements concerned the reconciliation system, and fully half of the grocers chose one of those as their top priority improvement.

Complaints focused on three points:

- The EBT system did not provide daily reports on EBT transactions or deposits. Monthly bank statements, which showed total deposits for each day, were the only routine written report. Some grocers arranged with their bank for a telephone call to get the deposit amount. Grocers also could get deposit amounts or a list of EBT transactions from the EBT Center, but only by special request.

- Manually authorized purchases were not credited on a predictable schedule. The grocer had to mail a copy of the receipt to the EBT Center. The grocer was credited after the receipt reached the EBT Center and the data were posted to the computer files. If a grocer performed a number of manual purchases over several days, it was virtually impossible to reconcile store records of EBT totals with deposit amounts.

- Store totals had to be manually calculated from journal tapes maintained by the printers. Each terminal maintained a running total of transactions since the "sign-on" at the beginning of the shift. The "sign-off" procedure caused the shift totals to be printed and reset to zero. By signing off a terminal at exactly 2:00 PM (the end of the EBT system's banking day), the grocer could obtain a total corresponding to a part of the EBT cycle.

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- The cashier telephones the EBT Center, gives identification information and the amount of purchase, and receives an authorization number (after the EBT operator has checked the recipient's balance).
- The cashier writes the authorization code, purchase amount, recipient's case number, and store identification number on a three-part receipt form.
- The cashier gives the recipient one copy of the receipt and keeps one for the store.
- The third copy of the receipt is sent to the EBT Center, which posts a credit to the retailer.

Recipients could make a maximum of $35 worth of manually authorized purchases in a single day. If the recipient had come to the checkout counter intending a larger purchase, he or she would have to pay cash for the excess amount or remove some items from the order.

Grocers objected to the time-consuming nature of the manual authorization and to the $35 limit. Sometimes they went to considerable lengths to avoid manually authorized sales. Many grocers had the recipient wait for a while to see if the system would begin working, meanwhile handling other transactions. Some allowed recipients to leave with their groceries and come back to pay later. A few grocers said they had allowed the recipients to leave with the groceries, but kept the recipients' EBT cards to make sure they would come back to pay for the purchase (this procedure was against program regulations).

The POS systems do not offer a particularly useful comparison to the EBT system on this issue, because the problems are different. The would-be POS customer may well have cash and, almost by definition, has a checking account. One of these two payment modes is generally available if the system is down or the transaction is rejected. If the customer has insufficient cash and no checks on hand, the store manager has the discretion either to risk some form of credit or a store check or to refuse the customer's purchase.

The Food Stamp Program cannot assume that recipients have any resources other than their benefits. It is not acceptable to deny the recipient the opportunity to buy food when the system is not operating. It might be costly for the Food Stamp Program to allow unlimited manual purchases, because

recipients could readily overdraw their accounts. The program, however, cannot require the grocer to absorb a loss if the recipient has insufficient benefits to cover the purchase. Thus, while the EBT manual purchase procedure is more difficult for grocers than the analogous POS procedures, the POS procedures would not meet Food Stamp Program objectives.

Training. Deposit reconciliation and manual authorization were the only major EBT features that many grocers considered difficult. Some other, lesser problems that arose seemed connected to the training of grocer staff.

The system contractor conducted training sessions for about 800 store personnel at the start of system operations. The sessions were conducted at a central location, involved relatively large groups (typically about 20 people), and lasted about one-half hour. Trainees did not generally get hands-on practice with "live" equipment, although manuals were distributed. Most stores sent one or two representatives to the training, usually including the manager. Those people trained any additional cashiers or other staff who needed to operate the system. Grocers indicated that the second-hand training was quite limited, however, usually lasting 15 minutes or less.

In addition to the initial, formal training sessions, PRC's field technicians asked store personnel several times during the demonstration (i.e., when the technicians went to the stores to perform preventive maintenance on the EBT equipment) whether or not more training was desired. If needed, the technicians provided hands-on training in the store.

Observers who saw both the recipient and the initial grocer training sessions generally considered the grocer training less successful than the recipient training. More material had to be presented to the grocers, and supplementary devices (videotape, hands-on practice) were used less. Survey responses bear out observer reactions: 68 percent of the recipients said they were "very satisfied" with their training; only 33 percent of the grocers felt their employees were trained "very well".

One possible indication of a training weakness is the frequency with which grocery personnel called the EBT Center with easily resolved problems. Many calls during the first few months dealt with simple issues of how to operate the equipment. Telephone logs for the first five months show an

average of 34 calls per month with questions about in-store equipment (the terminal, the printer, the modem, or the wiring connections) that were resolved by providing information rather than sending a technician to the store. This accounted for about a third of all calls to the EBT Center during this period. In subsequent months, after most store personnel had learned through experience (or possibly, later in-store training) how to operate the system, these calls dropped off to an average of 6 per month, or about 7 percent of all calls.

Store personnel in the Florida and Iowa POS systems conducted somewhat more intensive training than occurred in Reading. As the systems were introduced, cashiers received one to two hours of formal training, typically in a group format in the store, with hands-on experience included. (The Florida chain actually had a four-hour session, with about half the time devoted to how to "sell" and instruct the customer in using the system.) It is important to recall that no major problems seem to have resulted from the Reading training, but the POS comparison combines with other indicators to suggest that training was a relatively weak spot.

INFORMATION ABOUT ISSUANCE DATES

As documented in Chapter Three, peak transaction activity in the Reading system occurred immediately after issuance. During the first six months of 1985, the EBT Center often had a three- to five-day "window" prior to normal issuance dates (the fourth workday of the month) to post recipients' monthly benefits to their EBT account. Retailers were therefore sometimes surprised by heavy volumes of food stamp purchases earlier in the month than they expected. If sufficient numbers of cashiers were not available, this heavy volume tended to disrupt checkout operations.

The EBT Center responded to grocer complaints about uncertainty over issuance dates by adopting a policy of calling all retailers each month to let them know when recipients' benefits would be posted.

7.4 RECOMMENDATIONS TO AVOID THE READING SYSTEM'S EASE-OF-USE PROBLEMS

Because most recipients and grocers felt it was very easy to use the Reading EBT system, relatively few improvements would seem necessary.

Nonetheless, a few difficulties deserve attention, especially those related to grocer reconciliation procedures. Some suggestions on these issues are offered here.

1) Provide complete deposit information to grocers.

The sparse information grocers received about EBT activity was the system's most important shortfall in ease of use. It occurred daily, and was relieved during the demonstration only by stopgap measures such as special arrangements between grocers and banks.

An EBT system needs to provide grocers with routine reports of the financial transactions affecting their stores. Many stores need information daily, although not all do (in fact, some smaller stores with limited food stamp business prefer less frequent information). This means the system must be able to provide daily information on deposit amounts in a form that can be reconciled against in-store data. For supermarket and convenience store chains which have more than one store participating in an EBT system, the daily information should be broken out by individual stores even if they share a single bank account. The EBT system could have met these requirements with a daily deposit report with separate entries for manually authorized purchases.

For additional ease of use beyond the minimum requirement, any of the following features would also be desirable:

- transaction listings, with summaries by shift and terminal, provided by the central EBT facility if the in-store equipment does not have the capacity to produce them;
- in-store automated capacity to sum transactions by banking day without depending on human intervention at a precise moment; and
- reporting flexibility so that the system could vary the frequency and detail of reporting according to store needs.

Each of these features -- even simple deposit reporting -- implies some additional system capacity and cost. System designers must decide how much convenience is worth the cost. Tradeoffs also may exist between

timeliness and depth of reporting; more detailed reports may have to lag behind the next-day communication needed for deposit information. This would be especially true in a system like Reading's, where limited in-store equipment would not support extensive electronic transmission of data.

2) Raise the $35 limit on manually authorized purchases.

The Food Stamp Program has two basic objectives for situations when electronic purchases cannot be made in an EBT system. First, backup procedures must exist so that recipients will be able to buy food with their benefits. Second, the backup procedures must minimize the system's vulnerability to fraud or accidental overdrafts. A related requirement is that the procedures cannot impose risks on grocers. These objectives rule out the approaches taken by POS systems, and may make it impossible to design a backup system that grocers will consider truly easy to use.

One possible improvement to the Reading procedures would be to raise the $35 daily limit on manually authorized purchases. Raising the limit would reduce the number of situations in which recipients bring groceries to the checkout counter and then have to put some aside because the system is down. This situation does not seem to have occurred frequently, but it was irritating to both grocer and recipient when it did.

Raising the $35 limit will increase a system's vulnerability to overdrafts, but only by a small amount. The maximum vulnerability will be either the new limit or the value of the recipient's purchases since the previous night's listing of account balances (the "Shift" report), whichever is lesser.

Another grocer complaint about manual authorization was the delayed and unpredictable crediting of manually authorized purchases. This was principally a reconciliation issue, and would be largely satisfied by the recommendations above for reconciliation. An alternative approach would be to credit grocers immediately for manual purchases, with subsequent adjustment if the grocer fails to submit a receipt verifying the transaction. This procedure would introduce complications that are probably unnecessary if reconciliation reports identify manual transactions.

These modifications would not make the manual authorization procedure fully easy to use. Verifying the PIN, calling the EBT Center, filling out the receipt, and handling the receipt is still a cumbersome process. It probably cannot be streamlined much and still meet the program's objectives. Nevertheless, assuming that manual transactions occur very rarely, raising the $35 limit and improving reconciliation seems likely to satisfy most grocers.

3) Design the system so that it is easy for recipients to spend exactly what is left in their accounts.

The EBT system differs strikingly from POS systems in not giving the recipient a monthly statement of EBT account activity. Because such statements are legally required in POS systems, they may establish a customary standard that will come to be expected of EBT systems. This could occur even though the absence of a monthly statement caused no known problems in Reading.

Account balance problems in Reading most frequently seemed to concern the "spend-out" purchase -- i.e., the purchase in which recipients wanted to use all of their remaining benefits for the month. For example, a recipient comes to the checkout counter with a bundle of groceries, planning to pay mainly with cash but to use up the few dollars of benefits in the account. The cashier rings in the items and proceeds with the normal EBT actions. The transaction is rejected for insufficient balance, and the terminal displays the remaining balance amount. Recipient and cashier repeat the EBT process, but this time the cashier keys in the exact amount of the remaining balance, the transaction is accepted, and the recipient pays cash for the remainder of the order.

Two kinds of adjustments of the EBT system might make the spend-out easier. One would be to increase the likelihood that the recipient would know the exact amount of the remaining balance upon arrival at the checkout counter. This might involve giving the recipient a printed record in response to a balance inquiry, rather than just displaying the balance on the terminal screen. (This would require attaching printers to balance-only terminals.) The alternative strategy would be to redesign the dialog between the grocery terminal and the EBT Center computer. For example, after responding with an

insufficient-balance message, the system might allow re-entry of a different amount rather than disconnecting immediately.

4) Provide thorough training to grocers.

Grocer training in the Reading system seemed somewhat weak, both to observers and in comparison with POS systems. A reasonable minimum of training for cashiers or other system operators seems to be one hour, including hands-on experience with live equipment. Grocers would generally prefer in-store training to training at a central location, but this may be too difficult or costly when a system is being introduced in many stores simultaneously. Strong initial training, however, may reduce the need for costly on-going support.

Reading recipients had little difficulty with the EBT system. It is impossible to know whether this resulted from the extensive training and support that was provided, or whether the training and support was not really necessary. As EBT and POS systems become more common, it may be reasonable to assume that recipients will need less help. In the short term, however, it seems risky to reduce the level of training and support below that offered in the Reading EBT system.

Appendix A

SIMULATED EFFECTS OF STAGGERED ISSUANCE ON PEAK DAILY TRANSACTION VOLUMES

Appendix A

SIMULATED EFFECTS OF STAGGERED ISSUANCE ON PEAK DAILY TRANSACTION VOLUMES

The Pennsylvania Department of Public Welfare implemented a staggered issuance schedule for food stamp benefits in Berks County in July 1985. Staggered issuance did not reduce peak daily transaction volumes in the Reading EBT system. As discussed in Chapter Three, recipients' uncertainty about issuance dates prior to July 1985 and a general increase in total monthly transaction volumes during the demonstration confound the analysis of staggered issuance's effects on daily transaction volumes.

This appendix presents the simulated effects of staggered issuance on peak daily transaction volumes when issuance dates are known and with a constant monthly transaction volume. Two simulations are presented. The first simulation replicates the staggered issuance schedule implemented in Reading. That is, half the caseload receives its benefits on the fourth workday of the month, and the remaining half receives benefits one week later. In the second simulation, the remaining caseload receives its benefits two weeks after the first issuance date.

Exhibit A-1 presents the simulation results. The second column of the exhibit shows actual daily transaction volumes (both electronic and manually authorized) for March 1985, the only month prior to staggered issuance that benefits were posted on the fourth workday of the month (March 6). The peak daily transaction volume in March was 2,638 transactions, on March 6.

Column C divides column B's daily transaction volumes in half. If staggered issuance had been implemented prior to March, the figures in column C represent the likely transaction volumes generated by those recipients receiving benefits on March 6.

Column D copies the figures from column C, but lags the daily transaction volumes by one week. This column represents the expected daily transaction volumes for those recipients receiving benefits one week after the first issuance date.

Exhibit A-1

SIMULATED TRANSACTION VOLUMES UNDER A STAGGERED ISSUANCE SCHEDULE

	Single Issuance		Staggered Issuance			
			One-Week Spread		Two-Week Spread	
Day of Month	Full Caseload	Half Caseload	Second Half	Total	Second Half	Total
(A)	(B)	(C)	(D)	(E)	(F)	(G)
1	327	163	248	411	481	644
2	292	146	247	393	433	579
3	168	84	211	295	314	398
4	279	140	217	357	361	501
5	292	146	197	343	295	441
6	2638	1319	181	1500	286	1605
7	2535	1267	106	1373	179	1446
8	1938	969	163	1132	248	1217
9	1778	889	146	1035	247	1136
10	1283	642	84	726	211	853
11	1452	726	140	866	217	943
12	1411	705	146	851	197	902
13	1397	699	1319	2018	181	880
14	1347	673	1267	1940	106	779
15	1192	596	969	1565	163	759
16	1095	548	889	1437	146	694
17	786	393	642	1035	84	477
18	963	481	726	1207	140	621
19	866	433	705	1138	146	579
20	627	314	699	1013	1319	1633
21	723	361	673	1034	1267	1628
22	590	295	596	891	969	1264
23	572	286	548	834	889	1175
24	357	179	393	572	642	821
25	497	248	481	729	726	974
26	493	247	433	680	705	952
27	422	211	314	525	699	910
28	435	217	361	578	673	890
29	394	197	295	492	596	793
30	361	181	286	467	548	729
31	213	106	179	285	393	499
Total	27,723	13,861	13,861	27,722	13,861	27,722

Total daily transaction volumes for the simulated one-week staggered issuance are shown in column E, which sums the daily figures from columns C and D. The peak daily volume in this simulation is 2,018 transactions on March 13, the second issuance date. The simulation indicates that a one-week staggered issuance schedule would reduce the daily peak load from 2,638 to 2,018 transactions, nearly a 24-percent reduction.

If the staggered issuances were two weeks apart, column F represents the expected daily transaction volumes generated by those recipients receiving benefits on March 20. Total daily transaction volumes under this scenario are presented in Column G, which sums the daily figures from columns C and F. The peak daily volume in this second simulation is 1,633 transactions on March 20. This peak represents a 38-percent decrease from the single issuance daily peak of 2,638 transactions.

In an operational setting, the exact reductions in peak daily volumes with staggered issuance may be somewhat greater or lesser than those indicated by the simulations. The simulations are based on actual transaction volumes from only one month. Issuance problems occurred on March 6, and these problems may have marginally affected transaction volumes near this date. Furthermore, the simulations assume that the daily transaction volumes for the two groups of recipients will follow identical patterns, offset by the time between issuance dates. In months with major holidays occasioning large food purchases, this assumption may not be valid. Nevertheless, the magnitudes of the simulated reductions (24 and 38 percent) strongly suggest that staggered issuance dates can reduce peak daily transaction volumes in an EBT system by a substantial amount. Reductions in peak daily volumes should lead to similar reductions in peak hourly volumes, thereby decreasing the needed capacity requirements of the system.

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Appendix B

HOURLY DISTRIBUTION OF EBT PURCHASE TRANSACTIONS

Appendix B

HOURLY DISTRIBUTION OF EBT PURCHASE TRANSACTIONS

A State Agency needs two sets of information to monitor system performance if it specifies accessibility standards in terms of the maximum percentage of attempted purchase transactions which cannot be processed by the system. The first set of information deals with the time periods an EBT system cannot process purchase transaction requests. The second set of information is the expected hourly distribution of transaction requests (in percentage terms) which store terminals will forward to the system as food stamp recipients use their EBT benefits to buy groceries.

The expected hourly distribution of purchase transaction requests will be system specific. Factors affecting the hourly distribution of EBT purchases throughout a month include the particular shopping behavior of local food stamp recipients and the schedule by which the State Agency issues monthly food stamp benefits. Expected hourly distributions of purchase transactions, therefore, should be based on previous levels of purchase activity experienced by the system being monitored.

To illustrate the format of the needed information and its use in monitoring system accessibility, this appendix presents two exhibits of the percentage hourly distribution of purchases in the Reading EBT system. Exhibit B-1 presents information for April 1985. The EBT Center posted recipients' April benefit issuances on April 1. Exhibit B-2 presents information for September 1985, three months after the Pennsylvania Department of Public Welfare initiated staggered issuance in the Reading area. Regular monthly food stamp issuances for September were posted to recipients' accounts on September 6 and 12. Actual system downtime during both months was relatively low. The figures in the two exhibits therefore provide a close representation of system activity in the absence of major accessibility problems.

Suppose that a system operator reports the following periods of system inaccessibility to a State Agency, and that recipients' benefits in this particular system are issued on a single day during the month.

Exhibit B-1

PERCENTAGE HOURLY DISTRIBUTION OF EBT PURCHASES DURING APRIL 1985

DAY OF MONTH	HOUR OF DAY																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
1	-	-	-	-	-	-	-	-	.06	.09	.29	.32	.38	.40	.55	.56	.69	.66	.37	.38	.30	.17	.08	.05	5.38
2	.03	-	-	-	-	.01	.01	.05	.13	.29	.39	.49	.59	.56	.65	.71	.72	.76	.51	.41	.26	.16	.06	.04	6.83
3	.04	.01	.02	01	-	-	.01	.05	.14	.25	.39	.50	.63	.52	.61	.65	.73	.87	.47	.43	.32	.14	.07	.04	6.90
4	-	-	-	-	-	-	.03	.04	.19	.33	.41	.56	.58	.62	.77	.81	.85	.70	.55	.42	.34	.21	.09	.03	7.53
5	.03	.03	.01	-	-	-	.01	.06	.20	.32	.52	.67	.68	.65	.58	.58	.58	.59	.41	.33	.23	.10	.06	.08	6.71
6	.04	.02	.01	-	-	.01	.01	.04	.15	.29	.45	.62	.63	.63	.70	.63	.64	.65	.38	.38	.29	.11	.09	.06	6.84
7	.03	.02	-	-	-	-	.01	.01	.09	.15	.17	.15	.24	.23	.18	.18	.15	.12	.14	.10	.10	.09	.08	.02	2.28
8	.01	-	.01	-	.01	-	.02	.03	.11	.14	.39	.36	.48	.46	.48	.45	.57	.56	.31	.25	.22	.08	.05	.01	5.01
9	.01	-	-	-	-	-	.01	.05	.10	.14	.27	.32	.43	.38	.36	.41	.63	.53	.30	.27	.24	.10	.05	.03	4.63
10	.01	.01	-	-	-	-	-	.06	.13	.23	.25	.30	.37	.29	.45	.48	.54	.43	.28	.25	.21	.08	.05	.03	4.43
11	.01	.01	-	-	-	-	.01	.08	.12	.20	.22	.42	.40	.30	.29	.45	.50	.44	.28	.28	.22	.10	.06	.03	4.41
12	.01	.01	.01	-	-	-	.01	.08	.14	.22	.23	.25	.33	.29	.33	.37	.38	.44	.31	.24	.14	.08	.05	.01	3.92
13	.01	.01	-	-	.01	-	.01	.02	.13	.23	.28	.32	.29	.32	.30	.38	.36	.29	.25	.18	.13	.08	.07	.03	3.69
14	.01	.01	-	-	-	-	-	.01	.03	.17	.21	.19	.32	.29	.20	.23	.20	.19	.17	.14	.10	.06	.03	.03	2.59
15	.01	.01	-	-	-	-	-	.06	.10	.12	.16	.23	.27	.24	.29	.36	.43	.31	.23	.18	.17	.05	.04	.01	3.27
16	.01	.01	.01	-	-	-	-	.01	.08	.11	.18	.19	.25	.21	.28	.31	.40	.28	.19	.16	.11	.07	.04	.01	2.93
17	-	-	-	-	-	-	.01	.05	.11	.13	.13	.20	.18	.25	.28	.33	.34	.29	.19	.15	.11	.04	.02	.01	2.82
18	-	-	-	-	-	-	-	.04	.12	.10	.14	.18	.22	.25	.24	.24	.31	.29	.18	.19	.10	.06	.03	.02	2.74
19	-	-	-	-	-	-	-	.04	.10	.13	.18	.17	.15	.24	.27	.19	.29	.20	.17	.12	.12	.02	.04	.01	2.45
20	-	-	-	-	.01	-	.01	.01	.11	.18	.20	.16	.15	.24	.19	.17	.19	.18	.10	.13	.08	.04	.01	.01	2.20
21	.01	.01	-	-	-	-	-	-	.05	.11	.15	.19	.18	.18	.15	.13	.15	.08	.09	.13	.05	.02	.02	.01	1.62
22	-	-	-	-	-	-	.01	.03	.07	.07	.09	.12	.13	.13	.13	.13	.20	.17	.11	.07	.08	.06	.03	-	1.62
23	-	-	-	-	-	-	.01	.03	.08	.08	.10	.08	.14	.14	.13	.13	.15	.18	.10	.08	.08	.03	.01	.01	1.50
24	-	-	.01	-	-	-	-	.03	.03	.07	.10	.09	.13	.13	.16	.19	.15	.14	.10	.07	.06	.03	-	-	1.43
25	-	-	-	-	-	-	-	.01	.04	.08	.08	.15	.13	.13	.11	.13	.14	.15	.08	.09	.05	.02	.02	-	1.36
26	-	-	-	-	-	-	-	.01	.04	.07	.06	.10	.13	.13	.12	.11	.14	.13	.08	.08	.04	.03	.01	.01	1.25
27	-	-	-	-	-	-	-	-	.05	.06	.10	.09	.08	.08	.12	.09	.10	.11	.04	.08	.04	.01	.01	-	1.10
28	.01	.01	-	-	-	.01	-	-	.01	.05	.03	.06	.09	.09	.06	.08	.05	.02	.04	.05	.05	.02	.01	-	.71
29	-	-	-	-	-	-	-	-	.02	.06	.05	.06	.06	.06	.09	.09	.11	.09	.06	.08	.06	.01	.03	-	.94
30	-	-	-	-	-	-	-	.01	.03	.06	.04	.08	.08	.08	.06	.04	.11	.10	.08	.03	.04	.07	.02	.02	.93
Total	.29	.18	.09	.04	.05	.06	.21	.92	2.75	4.5	6.27	7.63	8.69	8.30	9.10	9.62	10.78	9.95	6.55	5.72	4.32	2.15	1.23	.62	100.00

Note: Marginal and total percentage figures may not sum due to rounding.

Exhibit B-2

PERCENTAGE HOURLY DISTRIBUTION OF EBT PURCHASES DURING SEPTEMBER 1985

DAY OF MONTH	HOUR OF DAY																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
1	.01	–	–	–	–	–	–	.01	.02	.04	.08	.09	.11	.08	.07	.06	.10	.10	.04	.05	.03	.02	–	.01	.91
2	.01	.01	–	–	–	–	–	.01	.01	.05	.11	.12	.11	.08	.05	.06	.08	.07	.05	.03	.05	.03	.01	.01	.98
3	.01	.01	–	–	–	–	–	.02	.02	.05	.09	.08	.10	.08	.14	.09	.12	.10	.07	.05	.05	.03	.01	–	1.12
4	–	–	–	–	–	–	–	–	–	.07	.06	.12	.10	.09	.08	.09	.07	.11	.06	.05	.04	.01	.02	.01	.99
5	–	–	–	–	–	–	–	.01	.06	.05	.08	.07	.08	.08	.06	.07	.10	.10	.06	.05	.05	.03	.01	–	.98
6	.01	–	.01	–	–	.01	.05	.16	.32	.40	.54	.61	.58	.58	.63	.50	.60	.57	.41	.37	.30	.16	.07	.04	6.91
7	.05	.02	.02	–	–	.01	.02	.06	.18	.30	.37	.36	.42	.42	.47	.49	.40	.36	.19	.20	.21	.08	.08	.06	4.76
8	.03	.01	.01	.01	–	–	–	.01	.09	.16	.31	.25	.36	.30	.29	.26	.13	.24	.20	.16	.19	.09	.08	.03	3.19
9	.02	.01	–	.01	–	–	.01	.07	.15	.13	.21	.31	.34	.19	.31	.38	.45	.35	.22	.19	.16	.14	.05	.02	3.70
10	.01	.01	–	–	.01	–	.01	.02	.11	.16	.24	.20	.22	.27	.30	.31	.43	.31	.19	.28	.18	.12	.04	.02	3.47
11	.01	.01	–	–	–	.01	.01	.06	.12	.16	.16	.25	.27	.26	.25	.27	.40	.38	.22	.19	.14	.08	.03	.02	3.31
12	.01	–	–	–	–	–	.01	.06	.12	.12	.17	.22	.25	.21	.26	.33	.30	.26	.24	.20	.14	.06	.03	.02	3.01
13	.03	–	.01	–	–	.01	.04	.15	.31	.50	.69	.85	.74	.78	.79	.79	1.03	.78	.64	.47	.30	.17	.10	.05	9.22
14	.03	.01	.02	.01	.01	–	.01	.03	.26	.37	.44	.63	.56	.52	.64	.68	.62	.61	.37	.27	.21	.18	.06	.04	6.60
15	.02	.03	.01	.02	–	–	–	.01	.09	.28	.41	.42	.44	.49	.39	.33	.30	.30	.23	.30	.17	.11	.06	.03	4.46
16	.01	.01	.01	–	–	–	–	.08	.14	.19	.32	.36	.44	.37	.58	.64	.61	.48	.34	.35	.30	.15	.08	.01	5.46
17	.02	–	–	–	–	–	.01	.07	.18	.24	.33	.37	.43	.40	.39	.51	.62	.54	.28	.30	.23	.14	.07	.04	5.18
18	.01	–	–	–	–	–	.01	.03	.18	.24	.34	.32	.39	.35	.39	.45	.58	.47	.28	.32	.22	.13	.08	.02	4.82
19	.01	.01	–	–	–	–	.01	.10	.17	.25	.26	.31	.37	.35	.34	.37	.53	.47	.26	.20	.17	.13	.05	.02	4.39
20	.01	–	–	–	–	–	.02	.07	.14	.16	.22	.32	.25	.30	.32	.33	.41	.32	.28	.18	.14	.07	.04	.03	3.63
21	.02	–	–	–	–	–	.01	.01	.11	.20	.26	.26	.32	.29	.27	.37	.26	.30	.17	.18	.12	.05	.03	.02	3.27
22	.01	.03	–	–	–	–	–	.01	.08	.18	.20	.31	.33	.18	.24	.19	.22	.16	.14	.14	.12	.10	.03	.02	2.70
23	.01	–	–	–	–	.01	.01	.04	.12	.12	.14	.23	.23	.28	.30	.29	.35	.28	.17	.15	.14	.06	.05	.01	3.00
24	.01	–	–	.01	–	–	–	.02	.09	.12	.20	.14	.24	.25	.18	.28	.37	.26	.16	.14	.15	.07	.01	.02	2.73
25	.01	–	–	–	–	–	–	.05	.13	.10	.11	.20	.23	.23	.16	.20	.28	.28	.16	.21	.09	.09	.02	.01	2.58
26	.01	–	–	–	–	–	–	.04	.08	.13	.15	.14	.20	.19	.24	.20	.31	.27	.17	.10	.08	.03	.02	.02	2.41
27	.01	–	–	–	–	–	.01	.01	.07	.10	.12	.15	.10	.07	.20	.18	.18	.17	.10	.11	.03	.05	.03	.01	1.71
28	.01	–	.01	–	–	–	–	–	.07	.14	.16	.14	.13	.17	.16	.16	.15	.10	.07	.07	.07	.03	.01	.02	1.68
29	.01	–	–	–	–	–	–	.01	.03	.09	.08	.11	.12	.15	.11	.09	.12	.08	.07	.06	.06	.03	.02	.01	1.25
30	.01	–	–	–	–	–	–	.03	.07	.07	.09	.12	.11	.14	.13	.11	.19	.15	.13	.07	.07	.02	.02	.03	1.59
Total	.42	.21	.12	.09	.03	.07	.25	1.24	3.52	5.17	6.96	8.07	8.59	8.15	8.74	9.11	10.33	8.99	5.96	5.44	4.20	2.48	1.21	.68	100.00

Note: Marginal and total percentage figures may not sum due to rounding.

- 30 minutes of inaccessibility between 11:00 and 11:30, three days after issuance;
- 25 minutes of inaccessibility between 15:50 and 16:15, ten days after issuance; and
- 10 minutes of inaccessibility between 20:14 and 20:24, 22 days after issuance.

The following table could be used to estimate the percentage of all attempted transactions during the month which could not be completed during the reported periods of inaccessibility.

(A) Days since issuance	(B) Time	(C) Duration (minutes)	(D) Hourly % of Monthly Transactions	(E) % of Monthly Transactions not Completed
3	11:00-11:30	30	0.50	0.250
10	15:50-16:00	10	0.48	0.080
10	16:00-16:15	15	0.54	0.135
22	20:14-20:24	10	0.08	0.013
Total				0.478

The numbers in column D are taken from Exhibit B-1. Column E numbers are computed as the product of column C (expressed as fractions of an hour) and column D. Note that the period of inaccessibility reported on the tenth day after issuance spans two hourly periods in Exhibit B-1. This period of inaccessibility is split by hour to enable use of the figures in the exhibit. The estimate of the total percentage of attempted purchases not completed due to system inaccessibility in this example is about 0.48 percent.

Appendix C

GLOSSARY

Appendix C

GLOSSARY

AB&T	American Bank and Trust Company. Reading bank which receives retailer deposit information and initiates funds transfer requests for the EBT system through the Federal Reserve system.
ACH	Automated Clearing House. Financial network used to process funds transfer requests.
ADP	Automated Data Processing.
ATP	Authorization-to-Participate Card. Card used in some jurisdictions to authorize delivery of food stamp coupons to program recipients.
BCAO	Berks County Assistance Office. The local welfare office serving the Reading area.
BIC	Benefit Identification Card. Photo identification card with encoded magnetic stripe used to access benefits in the EBT system.
BTT	Benefit Transaction Terminal. Equipment located at retail checkout counters to read recipients' BICs and to transmit transaction information to the EBT Center. Also referred to as Benefit Transfer Terminal.
EBT	Electronic Benefit Transfer. The EBT system uses electronic funds transfer and point-of-sale technologies for the delivery and control of food stamp benefits.
EBT Center	Local operations center for the Reading EBT system.
EFT	Electronic Funds Transfer.
FNS	Food and Nutrition Service. Federal agency within USDA responsible for administering the Food Stamp Program.
MARO	Mid-Atlantic Regional Office. Regional office of FNS serving the Reading area.
NACHA	National Automated Clearing House Association. All electronic funds transfer requests need to be transmitted in a standard format adopted by this association.
OGC	Office of the General Counsel of the United States Department of

OIG	Office of the Inspector General of the United States Department of Agriculture.

PDPW	Pennsylvania Department of Public Welfare. State agency responsible for administering Food Stamp Program operations.
PIN	Personal Identification Number. A four-character alphanumeric code selected by the recipient. This code must be entered on the PIN-pad attached to the BTT before any purchase transaction will be processed in the EBT system. Also required for balance inquiries.
PIN offset	A special number that is based on the recipient's BIC number and PIN.
POS	Point of Sale. Refers to equipment and systems that electronically debit clients' accounts and credit retailers' accounts as a sale is performed.
PRC	Planning Research Corporation. Contractor selected to design, develop, and implement the Reading EBT system.
:	Transaction Authorization Code. A number computed and transmitted by a store BTT for each electronic purchase and refund transaction. The number is based on the data being transmitted. The system's computers, upon receipt of transaction data, recompute the TAC. If the transmitted data have been degraded during transmission, the two TACs will not match and the transmitted data will not be processed.
USDA	United States Department of Agriculture.
VIO unit	Voice Input/Output unit. This unit is attached to the EBT system's computer and provides balance information in a synthesized voice when recipients call a special telephone number using a telephone with touch-tone service.